THE INTELLECTUAL OBSERVER.

JULY, 1863.

THE MICRO-LEPIDOPTERA.

BY L. LANE CLARKE.

(With a Coloured Plate.)

WHENCE come the pretty moths that are figured in this opposite page, of beautiful hues and metallic lustre; the natural size indicated by a mere dot outside the magnified representation? They are glorious as the Admiral and Peacock butterflies in the variety and richness of their plumage, whilst in their instincts they are as wonderful as any of their larger brethren. Few are the observers of the little beings from which these microscopic moths develope. Those who have applied themselves to the study of these minute Lepidoptera have recorded their labours in volumes almost unattainable to ordinary lovers of natural history.* Seven of the ten promised volumes on the Micro-Lepidoptera, by Stainton and Zeller, have appeared; but it is much to be desired that a cheap manual of these interesting little creatures may soon be at hand for our guidance through the woods and along the hedge-rows, as we ramble on a summer's evening.

It was one of the wonders of my childhood what the hieroglyphics upon primrose, bramble, and rose leaves could possibly mean. I saw a white winding stream meandering along with a dark wavy line in the centre, beginning at a mere speck and swelling into a broad river, then suddenly ending. Holding a rose-leaf to the light, one day, there was life within that winding way, a sheltered, naked little worm sustained in the narrow channel between the upper and lower cuticle of the leaf; food, safety, warmth, all provided within the limits of the rose-leaf mine. Picking open the upper skin and finding a small green caterpillar, curious to know its metamorphosis, and failing to preserve the larvæ in the gathered leaves, I bethought me of muslin bags, which I tied over the twigs of rose-trees and

* *Natural History of the Tineina.* By H. T. Stainton and Zeller and Douglas.

XUM

brambles, laburnums and lilacs, which were the first mined and rolled leaves I had observed; and great was my joy when from these pages of nature's own book I first learnt the mysteries of the microscopic moths.

Every folded leaf is in truth the habitation of the larva of a minute Lepidoptera, and beneath the leaf a blotch, a pucker, or a tiny tent will, if watched, produce one of these beautiful objects. Scientifically they are divided into leaf-miners, leaf-rollers, tent-makers, and burrowers in the stems of the plant whereon they feed. Not *all* leaf-miners produce Lepidoptera, for several of the Diptera begin life in the same way. The primrose, whose leaves are often covered with irregular, fantastic markings, feeds the larvæ of a small, striped, greyish black fly with yellow legs (*Phytomyza primula*). The thistle is mined by a yellow and black fly (*Phytomyza sonchi*). The turnip and pea by the little yellow *Drasophila*. The plantain, ranunculus, stellaria, lychnis, chenopodium, and silene, are all mined by *Phytomyzides*. The iris, verbascum, euphorbia, by *Agromyzides*, very minute black or black and yellow flies, some of them with bright red eyes, but so small as to be really microscopic; not one line in expansion, yet sad devastators in the garden are they.

But the larvæ of a Diptera may always be recognized from that of the Lepidoptera, at least under the microscope, by the absence of feet in the dipterous larva, and the presence, however minute or rudimentary, of these organs of locomotion in the lepidopterous larva. Sometimes, it is true, the undeveloped condition of the true legs, and the absence in all leaf-miners of the coronet of hooks upon the pro-legs, or membranous feet, on the hinder segments of the body, may create a doubt, as it did in the mind of the great naturalist De Geer, when on finding the rose leaf-miner and examining the larvæ, he thus writes:—

"After examining their figure and the conformation of some of their parts, one would only take them to be *vers* or dipterous larvæ, because they have eighteen legs, all membranous and alike in form, exactly like the legs of *Fausses-chenilles*, or larvæ of saw-flies; that is to say, without the coronet of hooks which distinguish the true caterpillars.

"I thought therefore at first that these were a new species of dipterous larvæ. Sometimes I was inclined to consider them the larvæ of saw-flies, but as they had no horny legs, it seemed to me that they could not belong to these insects. In fact, I persisted in the opinion that my leaf-miners were dipterous larvæ, till they assumed their last form—till they showed me that they changed into true moths."

It was of the rose leaf-miner (*Nepticula anomella*, Fig. 6) that De Geer wrote thus, and it renders the species particularly

interesting when we know that it was the first of the miners which attracted his particular attention, and subsequently led our own naturalists, Westwood and Stainton, to the study of the Micro-Lepidoptera. The little moth itself is frequently found on our windows in the early spring, the dark grey or bronzy wings tipped with violet, and silvery grey under-wings, deeply fringed with delicate cilia. All these microscopic moths are remarkable for the extraordinary size of their scales, and many of them for the rich metallic lustre, iridescent as the scales of a diamond beetle.

To assist the young student in present research, we will notice and describe the species figured of our commonest leaf-*miners*, leaving the leaf-rollers and tent-makers for a future paper.

(Fig. 1.) *Cemiostoma scitella.*—To those who live in or near London there will be no difficulty in watching the development and securing specimens of this lovely microscopic moth, for the larva is abundant in July and August, disfiguring the leaves of hawthorn, apple, and pear with irregular flat brown blotches, and if we hold one of the leaves to the light, the little miner may be seen feeding busily. Also upon a still evening, or on the sheltered side of a hedge, we find in the month of June numbers of small grey moths creeping slowly about the leaves depositing eggs. Their minute size renders the exceeding beauty of their wings indiscernible to the naked eye, and difficult is it to mount them without ruffling the delicate plumage. This is just one of those surprises which an observant mind obtains, when in a mere dot of life such elaborate finish and perfection is discovered. A little creeping ashen-grey moth spreads a pair of upper wings clothed with feathery scales, that require the utmost power of human skill in microscopic lenses to investigate. On the membrane of this wing, which has a definite tracery of veins marking the species, there are rows of cup-like sockets into which each tiny scale is fitted securely for the insect's flight, but will not bear the coarse touch of human fingers. These scales, invisible to us, are composed of three distinct laminæ, two external and coloured, the inner one, a highly polished colourless membrane, which reflects the light and increases the brilliancy of each scale. The wing of this little *Cemiostoma*, shining with the silvery grey mass of microscopic feathers, has a large black spot with violet eye, and streaks of purest white, and deepest black, radiating off into the long silken fringe that is so remarkably beautiful in all these moths. We had not dreamt of such an object for our binocular.

The development of *C. scitella* is as follows: The egg, strangely large for the size of its mother, is laid on the under-

side of a leaf, and the larva, as soon as hatched, bores through the cuticle, and eats away a cavern in the parenchyma, which daily spreads into a large blotch, brown at first but afterwards white, with markings of black in half circles. This is the excrement of the worm as it works from side to side. When full fed, it comes out at the upper side of the leaf, and spins a pretty white cocoon, leaving a slit at one end through which it ejects the cast-off skin when assuming the pupa state, and by which the little moth eventually comes forth.

(Fig. 2.) *Cemiostoma laburnella.*—Lamenting over the disfigurement of our laburnums, every leaf blurred and blotched by the larva of this species, we shall forgive the little depredator when gazing on the beauty of the delicate white moth, and with a half-inch object-glass look down upon the violet pupil on its wings.

Mount this species on a blue disk, for then the radiating fuscous streaks in the cilia will be more distinctly seen.

There is another moth, *Cemiostoma spartifolia*, which mines the *twig*, not the leaf, of the common broom, so like the *Laburnella* that only a practised eye could discern the slightest difference, and yet there is invariably one little variation marking its individuality.

The wing of *C. laburnella* has three *parallel* lines from the second yellow dot through the cilia. The wing of *C. Spartifolia* has three *converging* strokes from the same dot.

Two broods in the year help each other to spoil our laburnum leaves in appearance, not in reality; for although the little insect feeds upon the pulp of the leaf, the veins or channels of the sap are uninjured, and the tree itself does not suffer in vitality. The first brood of *Cemiostoma* comes forth from the mine in July to spin cocoons, and fastens them to branches of the tree; but the second brood in October descend by little silken ropes, and hide themselves amongst dead leaves, spinning a pure white cocoon, firm and warm, wherein to sleep securely through the long winter.

(Fig. 3.) *Nepticula aurella.*—The *Nepticulæ* are the most minute of all the Micro-Lepidoptera, and the most easily observed, as they mine our familiar rose-leaves and brambles, but are not by any means easy to catch, for unlike the quiet and rather sleepy *Cemiostoma*, the *Nepticula* runs with wonderful rapidity, and though they may be found at rest on palings or trunks of trees, yet they are wary, flit off at our approach, and the delicate wings will hardly bear the sweep of a net; it is better to breed them by collecting the cocoons, or enclosing a bramble branch in a muslin bag. The cocoons of *Nepticulæ* are always found in groups of about twenty, though the larvæ are quite solitary in their spinning and feeding.

At any time in July, if we observe the bramble-leaves, we shall find many of them mined by the little *Aurella*—a wavy line running from a minute spot near the edge of the leaf along the border, then doubling back and widening to the end. Open this, and we find a small larva of fine golden colour, with a brown head, and a body so transparent that the circulation may be seen, and the peristaltic movement of the digestive organs. Turn it on its side and we see too many legs for a true caterpillar, which has always six short-jointed scaly legs in front, and from four to ten false membranous legs, armed with a coronet of little bent hooks; whereas *Leaf-miners* have eighteen legs, all membranous and undeveloped, without hooks on any of them, nor are they placed in caterpillar fashion on the body, a circumstance worthy of attention. The first segment of the body has no legs at all; then follow nine pair consecutively, leaving the eleventh and twelfth segments without any appendages.

The head we observe has two flat slender mandibles, projecting considerably in front, adapted for the insect's habit of feeding on the parenchyma of the leaf, without injuring the veins of the leaf or the cuticle. We can watch the action of these mandibles by holding up a leaf to the light, and using a pocket lens. Right and left the little creature wags its head, tears out the soft green pulp, which it swallows, and, widening the channel as it grows, breathes doubtless through the open windows of the uncovered stomata.

When the larva of *Nepticula* is full fed it quits the mine, and walks about seeking a convenient place for transformation. They will spin cocoons quite readily in the corner of a pill-box, and may be collected in October, when they sleep till the following June; but if taken in July, they will emerge as the golden-striped *Aurella* in about three weeks, forming a double brood every summer.

(Fig. 4.) *Nepticula trimaculella.*—Common in all parts of England is this pretty spotted moth, about May and June resting on the trunks of oak-trees. The larva, which is green and shining, with a reddish head, and red dorsal vessel, pulsating visibly under the microscope, mines oak-leaves in a blotch about an inch long, close to the mid-rib, from which it issues to spin a pale, yellow, mussel-shaped cocoon. The *Nepticulæ* always mine the *upper* side of leaves, except this species, which is sometimes found on the *under* side.

(Fig. 5.) *Nepticula sub-bimaculella.*—Another little oak-miner, but not double-brooded, and so only found in October in the larva state, making a triangular blotch in an angle between the mid-rib and one of the veins. The egg has been laid on the *upper* side of the leaf close to the mid-rib, and the

larva has kept very close to the rib, leaving a thick, black, central line of excrement; after which it turns about and eats out a blotch, in which, as it grows, the excrement is deposited in grains. From these observations it appears that the excrement is always fluid in the early stage of larva life, and becomes solid as the digestive organs develope.

(Fig. 6.) *Nepticula anomalella.*—This little moth has been already noticed as the subject of De Geer's observations. We can readily find specimens upon our rose-trees in July and October, mining in serpentine galleries the *under* side of the leaf, but coming out at the upper side, and spinning a cocoon at the footstalk of a leaf, or under a projecting thorn. There is another leaf-miner on the rose, *N. Anguli-fasciella*, much prettier, having dark wings, and a curved silver band across; and in the larva state they may be distinguished by the *Anomalella* being amber-coloured, and other of a pale green. We often find three or four of these little miners on the same leaf, in which case they cross each other's path, and make the tracing of a single mine rather difficult.

(Fig. 7.) *Lithocolletis stettinensis* (*Argyromiges*).—The family of which this beautiful moth is a member contains seventy species, so delicately small, and yet so brilliant, that naturalists have called them the humming-birds of the Lepidoptera. The larvæ are extremely abundant on the elm, maple, honeysuckle, scabious, oak, and nut trees. The young collector may forthwith (on reading this paper) begin to observe the leaves of these trees and plants, and learn to distinguish between the mine of a *Nepticulæ* and that of a *Lithocolletis*. Some species mine the upper and some the lower cuticle of a leaf. It is found that the larva of a *Lithocolletis never quits its mine*, but changes therein to a pupa; and the empty pupa-skin may be found protruding from a slit in the cuticle after the escape of the perfect insect—which will decide the question in this instance, as the *Nepticulæ* always emerge from the mine, and fix themselves to a stalk or a dead leaf for transformation. There is but one exception, and that is with *Nepticula septembrella*, which mines the leaves of *Hypericum pulchrum* (small upright St. John's wort) in autumn, making extremely slender mines around and across the small leaves; when full fed, they pucker the leaf a little, and form a cocoon inside the mine.

Again, the larva of a *Lithocolletis* more or less contorts the leaf, which *Nepticula* does not, and carpets the loosened cuticle with silk, pulling it so tight that not only does the skin pucker, but the opposite side of the leaf is drawn into a curve.

One more distinguishing mark may be given. The larva of a *Lithocolletis* has only fourteen feet, and the third and fourth segments are considerably enlarged; whereas a *Nepticula* has

eighteen feet, and uniform segments. I have also observed that the summer brood of *Lithocolletis* transform into a brown pupa, but the autumn brood spin a small yellow cocoon within the mine for the preservation of the pupa during the winter months.

The leaf-miners abound in July and October, and the dead leaves of the oak contain the pupa of *L. roboris, hortella,* and *Amyotella* all the winter through, producing very pretty moths. The *L. stettinensis* is found mining the upper side of alder-leaves; but a species extremely like it I have reared from rose-trees, of a deep reddish orange colour, barred with silver, edged with black, *without* the black spot which *stettinensis* has upon the margin of the wing. The elm feeds the beautiful little *L. Schreberella,* bright orange, dotted and barred with silver; the maple gives us abundantly that pure white moth, *L. sylvella,* which has yellow bars bent into angles, and edged with large, jet-black scales. All round London, Oxford, Bristol, Shrewsbury, we fail not to find this little miner blotching the leaves in July and October.

(Fig. 8.) *Tischeria marginea.*—With folded wings, closely pressed to the substance upon which it rests, this pretty moth sits with head slightly raised, and long antennæ thrown forward. We see it in May and August flitting over the brambles. The bright yellow dot of life is absorbed in the work of instinct, depositing its eggs on the under side of the blackberry-leaves, which will soon have the tracery of a little mine, resembling a *cornucopia,* and puckered at the widest part because the *Tischeria* does not quit that shelter, but changes to a pupa in its mine. Side by side we may observe the more wavy and intricate hieroglyphic of the *Nepticula,* and compare the larva; for the miner of *Tischeria* really requires a microscope to distinguish any feet at all. The moth is four lines long, and is first cousin to the *Elachistadæ,* or Grass-miners, of which we have figured—

(Fig. 10.) *Elachista luticomella.*—Until lately these were but little known. Stainton (our best authority) names forty species of the Grass-miners, who, when full-grown, quit the mine, and attach themselves to the stem of a neighbouring plant. They fix their bodies by a silken belt, like the cabbage caterpillar, and change to an angulated pupa. This pretty *E. luticomella* may be seen in swarms on summer evenings, hovering over their favourite *Dactylis glomerata,* and which feeds the young larvæ.

The prettiest specimens to seek are the—

E. Brunnichella, a golden-brown moth, barred and dotted with gold; found in hedges during May and August.

E. Gleichenella, which has brown wings, also spotted and

barred with brightest gold, and found flying over short grass under furze-bushes.

E. chrysoclista, common in St. James's Park in June and July; remarkable for its *metallic tufts* on a deep orange-coloured wing, bordered with black, and with purplish-black under-wings. It has three tufts of black and silver scales on each wing.

(Fig. 11.) *Ochsenheimeria* is properly not a microscopic moth, for it is from five to six lines in expansion, and not particularly beautiful; but the head is most curious, and deserves observation (Fig. 15). Those feathered antennæ and bird-like eyes are unlike all other moths. We can only catch this little grey fellow in the hottest part of the day, from 12 A.M. to 2 P.M., when it hops about the grass, depositing eggs on the *Dactylis glomerata*. It is marvellously quick in hiding away, and if not swept into the net whilst on the wing, will not be easily secured.

(Figs. 12 and 14.) The *Gelechidæ* have varied habits, for the larvæ of many of them feed between the united leaves of sallows, honeysuckle, firs, oaks, and apple trees. One species, *G. mulinella*, luxuriates in the sweet flowers of the broom and the furze in July and August. *G. malvella* (Fig. 12) is a plague to the florist who may especially care for his hollyhocks, and grieve to find his seeds devoured by the larvæ of this moth; but *G. hermanella* (Fig. 14) is a true leaf-miner. We find the larvæ making dirty green blotches on the leaves of *Chenopodium* and *Atriplex*, and the moth, flitting over these plants in July and October, is bright orange red, flaked with silvery streaks, and set off by jet-black scales. These moths are scarcely microscopic, being from *six* to *nine* lines in expansion.

(Fig. 13.) *Cerastoma xylostella*. — Measures ten lines across the out-stretched wings, yet it belongs to the Micro-Lepidoptera, and its larva, bright green, with scarlet stripe along its back, will in July be feeding on the honeysuckle.

(Fig. 9.) *Glyphipteryx equitella*.—Not a leaf-miner, but a *burrower*, and with a truly microscopic beauty, for the exquisite markings of its wings are never well seen except with a pocket lens or a three-inch object-glass. The dark bronzy-grey ground is streaked with pure white, edged with silver; two violet-silvery spots in the middle, and another at the tip, near which a hook of jet-black scales project through the cilia. This moth flies over the stonecrop in June, where it deposits the eggs, from whence a little miner comes forth to plunge into the stem, and work away in a channel through which it revels in the ascending sap. Another extremely pretty species is the dark-green *Thrasonella*, abundant amongst the rushes in June and July; and these are so varied that no two are exactly alike.

The wings of *G. Thrasonella* have streaks of bluish silver more or less distinct, and the large blotch of black lightened by three silvery violet eyes may not be found equally brilliant in all; even the cilia is sometimes more broadly tipped with white, and the bronzed green thereby relieved. The size also varies from *three* to *six* lines across.

Then, upon the pure white clustered blossoms of *Anthriscus*, or Wild-beaked Parsley, we frequently see a dark, small moth resting, and then running to and fro, raising and depressing its lovely wings as if fanning itself. This is *G. Fischeriella*. We know not where its larva feeds, nor is it confined to the *Anthriscus*, though it seems to love *that* flower best. We find it in the garden upon candytuft and other flowers; also swarming round young fir-shoots. Only with a microscope can we rightly see the tinted plumage of the dark velvetty wing, striped with white and silver, and having one rich violet eye in the anal corner.

I have but to notice the head of *Coriscium* (Fig. 16), an oak-leaf miner, plentiful in April, June, August, and September, whose drooping and tufted palpi show us the minute yet decided variations which mark the species, as well as the beautiful-plumed head of *Ochsenheimeria*.

Pondering on the hieroglyphics these little miners trace, words of infinite wisdom to the eye that can read and the heart that can understand; seeing how in darkness yet perfect security the naked worm feeds, grows, and developes a new and wondrous beauty of which it is wholly unconscious, and of which for thousands of years man was profoundly ignorant; we pause reverently before the tracery on a rose-leaf, the blotch on the laburnum, and we look beyond the present mystery of our own life, oftentimes a dark and a winding way, with a hope strengthened in looking at the glorious wings of the hitherto scarcely appreciated Microscopic Moth.

ON FOSSIL OTOLITHS,

AND NOTES ON THE

AUDITORY ORGANS OF THE LOWER ANIMALS.

BY W. W. STODDART, BRISTOL.

THE subject under consideration is one of the highest interest both to the geologist and comparative physiologist.

The fossil otoliths of fishes have generally escaped the notice of fossil collectors, which is the more strange, as the author has obtained some hundreds of specimens from some of the British strata. Nor are they described in any work yet published on geology. The nearest approach is in the first volume of the *Geological Journal*, where Professor Owen describes the petro-tympanic bones of four species of fossil Balænidæ from the Suffolk crag.

It indeed appears that very little is said by any author on comparative physiology concerning the auditory organs of recent osseous fishes. This in some measure arises from the universal dissection of *cartilaginous* fishes, whose heads, being more transparent, are easier of manipulation.

A few years ago an esteemed friend of the author's, E. T. Higgins, Esq., well known in the geological world, while examining the marine sand from Hordwell Cliff, found some curious little fossils which had never been figured or described. A careful examination and comparison proved them to be really the "otoliths" or ear-bones of fishes.

In the February number of the *Zoologist* for 1859, Mr. Higgins published a short notice, stating the fact that he had found the ear-bones of many recent genera of fishes in a fossil state. Since that time both he and the author have been carefully examining all the geological strata for these remarkable little fossils. And so successful has been the investigation, that besides several new facts in the anatomy and natural history of fishes, the fossil otoliths of the cod, whiting, whiting pout, power cod, pollack, flying fish, and many of the Pleuronectidæ have been determined.

They have been principally found in the Crag of Suffolk, the Eocene beds of Sussex, Hampshire, and Isle of Wight.

In a very remarkable bed in the Bristol Lias, the author has collected a body that very probably may turn out to be an otolith of the Pholidophorus; but as only one specimen has yet been found, its nature cannot yet be determined with perfect confidence.

In order to ascertain the species of fish to which the several

ear-bones belong, it is necessary to dissect an immense number of heads; for a most striking fact has been demonstrated, and one without analogy in natural history, viz., *that a characteristic form is more peculiar to the species than the genus or family.* That is to say, the ear-bones of a species have invariably a configuration peculiar to itself. But no form has yet been observed that will point out a genus, family, or tribe; for example, the same general form is equally found in the ear-bones of the Clupeidæ and Scombridæ, but still there is no difficulty in determining, with the greatest confidence, the specific name of a mackerel or a herring by the markings on their ear-bones, because they are always constant and never the same in two species.

With all these interesting relations and the frequency of their occurrence, it is very remarkable that the fossil otoliths have not been noticed before. The collection of Mr. Higgins and the author contain more than forty species of fossil otoliths, all distinct, and many of fish hitherto unknown in the fossil state.

Otoliths occur much more abundantly in the tertiary beds than any other parts of fishes, and much more so than the teeth. This fact at first sight may appear startling to the collector from the palæozoic rocks, when the commonest remains are the teeth, spinous defences, and scales. But a little reflection will easily solve the apparent riddle.

In the Silurian, carboniferous, etc., seas, the principal inhabitants were cartilaginous fishes, and the hardest and most indestructible portions of their bodies were the teeth and spines; whereas in the later tertiary beds the osseous fishes predominated, which do not possess the fin-spines or solid crushing teeth. Of them the hardest parts are the ear-bones in question.

That they are really the otoliths of osseous fishes their figure and configuration undoubtedly prove; but the more clearly to explain the position and function of an otolith, it will be better to trace the development of the auditory organ from the lowest organism in which the author has noticed it, to the complete and elaborate ear of the mammifer.

Sound is the vibration of solids and fluids propagated by means of waves through some intervening medium. At least such is the present theory.

Now the office of an ear is to intercept and collect these undulations, and to convey the result to the brain of the individual.

In every auditory organ there are two things absolutely necessary, viz.:—

1st. A fluid wholly or partially filling the internal ear.

2nd. A solid body or bodies of greater specific gravity than

the surrounding substance over which the auditory nerve is expanded.

On reviewing the different forms of ear, we find these conditions always present.

Of course animals that live in two media that have such different densities as air and water, require two distinct adaptations of auditory apparatus, although the same principles are present in each.

A sound that would be melodious and musical to the human ear would be absolutely stunning to that of a fish, simply from water being a better conductor than air.

Abbé Nollet performed many experiments to prove this. While totally immersed in water, he struck together two pieces of stone or metal, when the resulting sound as perceived by the ear was quite unsupportable.

The simplest form of an ear is that found in aquatic animals. It is at the outset merely a cavity filled with fluid, over the surface of which a nerve is expanded. This only receives the vibrations in a very imperfect manner, and is quite incapable of resolving them into tones.

This simple arrangement is by no means the usual one; commonly the sac is *enclosed* and filled with a *gelatinous* fluid (endolymph), which, when the undulations were received, would, on account of its greater specific gravity, more clearly communicate the full force of the sound, through the nerve to the sensorium.

The next step to increase the hearing power is the addition of a solid to this gelatinous fluid, and which, according to well-known acoustic laws, would materially increase the sensibility to vibratory influence.

A still greater advance is the suspension of the whole in a more liquid material (the perilymph).

Almost every seaside visitor will recollect an apparently lifeless mass of jelly that so frequently lies on the beach. Divide it with a knife, and it shows no sensibility. Cut it into a dozen pieces, and it offers no opposition. Lay it out to dry in the sun, and what before was so many pounds is now scarcely as many grains, only a mere film. The most acute observers have as yet failed to prove the presence of a nervous centre. Nevertheless this living wonder possesses ears! and those of a very beautiful construction.

On placing this seemingly inert mass in a little sea-water, it will unfold in the most elegant proportions, and is at once perceived to be the *Rhizostoma pulmo*, or sea-blubber. When a small piece of the edge of the *umbrella* is placed under the microscope with an inch lens, a small notch with a cavity will readily be seen. In the centre of this is a small body suspended

by a ligamentous neck, resembling very closely the clapper of a bell. This is the auditory apparatus, and the small suspended body is in reality an otolith, which rapidly oscillates at the rate of about 100 times a minute. In a small specimen it measured $\frac{43}{1000}$ of an inch in diameter. Many authors state that they have never observed these oscillatory movements, but in this species they may be readily seen.

In the rhizostome the author has failed to detect the little prisms which Mr. Gosse and others have remarked in the auditory capsule of the *Medusa aurita*. Neither graduated pressure with the compressorium, nor the delicate action of polarized light had any effect on their demonstration. When mounted in a deep cell, this little auditory capsule is a very beautiful object for the binocular microscope.

Strange to say, common as the insect class are, and well known their powers of hearing, yet the auditory apparatus has never yet been satisfactorily made out. Ramdohr has placed it in the jaws, Strauss-Durckheim in the antennæ, De Blainville in the sides of the body, and Agassiz in the legs! Most probably they will be found in or near the head; the experiments and preparations of Treviranus and others go far towards the support of this idea.

In the Crustaceans, the auditory organ is easily made out and seen by examining the base of the larger antennæ of a lobster or crawfish. It is a little prominence of very hard shell, having a circular opening at the apex, across which is stretched a thin membrane. Inside this is a sac filled with liquid, and having the auditory nerve distributed over its inner surface. Under the bottom of this sac, in some species, is a small triangular otolith, which is in direct contact with the nerve.

Dr. A. Farre, in a communication to the Royal Society, disputed this, and affirmed the locality of the ear was on the lesser antennæ. His views are, however, untenable. One reason only need be adduced, viz., that the auditory nerve may by careful dissection be traced to the prominence on the greater antennæ before mentioned. This fact is beautifully shown in a dissected specimen of the lobster, by Dr. Brittan, and now in the Bristol Museum.

Siebold was the first to notice the organs of hearing in the next great class of invertebrate animals, the Mollusca. In the Conchifera it is situated in the foot, and consists of a large central ganglion, on each side of which is a minute cavity filled with the usual endolymph, and inclosing a small otolith.

With a half-inch objective this otolith may be conveniently seen in the Cyclas, having a rapid oscillatory motion.

In the Gasteropoda this organ occurs at the base of the

tentacles. In the auditory sac are three otoliths, the shape of which varies according to the species. Here, for the first time, the otolith shows a *groove* for the reception of a suspensory ligament.

In the Dibranchiate Cephalopods the first approach to a labyrinth is seen.

We now come to the second grand division of the animal kingdom, Vertebrata.

In fishes, we find the organs of hearing have a great and important addition, viz., "the labyrinth," consisting of three semicircular canals communicating with a vestibule, which, with two ampullæ formed by an expansion of the semicircular canals, give rise to three cavities at each side of the base of the brain.

In these cavities are contained the organs of hearing, which in all fishes possess the same parts, differing only in specific differences of form and configuration, as would be expected.

In no work on fishes, especially the osseous ones, have these organs been correctly described. Moreover, those descriptions already published seem to have been from cartilaginous fishes.

The examination of an osseous fish is the better one for comparison with the fossil otoliths before mentioned. The best species for the purpose of study are the skate, herring, mackerel, or salmon.

In each of the before-mentioned cavities, that is, the vestibule, with an anterior and posterior ampullæ, is an otolith, so that in the head of every fish there are *invariably six otoliths.*

The central otolith is very much larger than the other two. They are connected together by a tough ligament, which, after enclosing the two smaller outside otoliths, passes under the central one through a groove for that purpose. All are suspended in a gelatinous endolymph and enveloped in a thin membrane something like the white of an egg, or the humour of an eye. Over this membrane are spread exceedingly minute branchlets of the auditory nerve, which traverse and anastomose in every direction, forming an exquisite network, which literally suspends the whole in the limpid perilymph, that completely fills the semicircular canals, vestibule, and ampullæ.

The cartilaginous fishes have the same number of otoliths, but they are not so hard and brittle, from the non-deposition of carbonate of lime.

The otoliths are evidently formed by the semi-crystallization of carbonate of lime in a gelatinous fluid, a condition which is well known to every chemist as interfering with the proper crystalline angles and planes by altering the regular arrangement of the calcareous particles.

For the sake of convenience, and for a slight analogy, here-

after to be mentioned, to the ossicula auditûs of the mammalian ear, the author has given to these three otoliths the provisional names of Malleolus, Incudeolus, and Stapeolus.

The malleolus is the otolith found in the posterior ampulla. It varies very much in size, shape, and position; most usually it is semi-transparent, very thin, and has the interior margin pectinated. Under the microscope it shows exceedingly well the calcareous granules in the course of deposition. It is the most delicate of the three concretions. In some fishes it lies upon and across the end of the neighbouring otolith.

The second and largest otolith is the incudeolus. It is that which is found in the fossil state. Its form is oblong, usually broader at the anterior than at the posterior extremity, and convex on the upper surface. On the convex, or under side, is a peculiarly-shaped groove for the suspensory ligament which connects the three otoliths. The shape of this groove is one of the most important and characteristic marks that are constant to each species.

The incudeolus differs in the Pleuronectidæ altogether in general shape, being truncated at both ends, and having a broad, flat subquadrate figure.

It is this otolith which the author so strongly insists upon as a trustworthy evidence in cases of specific identification. That is to say, so constant is the shape of this otolith to each *species* of fish, that the genus and species of any fish may be determined with the greatest accuracy by a careful inspection alone of this one otolith.

Some families have a slight general configuration which may assist the investigator to the possibility of a species, but nothing short of an absolute identity in the otolithic shape, and most especially that of the ligamental groove, will answer for certain identification of a species. But fortunately so exact and constant are these characters that no difficulty will be found when once the otolith of a fish has been seen. In this, however, arises the labour of identifying a fossil species, because the specific name cannot be determined until a recent specimen of the same species has been dissected.

In the Gadidæ, which comprise some of the most abundant of the fossils, the incudeolus is pyriform, rugose, and thick; this is exemplified by the whiting pout (*Morrhua lusca*).

In the Clupeidæ it is furcate at one extremity, as in the herring (*Clupeus harengus*).

In the Salmonidæ it is furcate at both extremities, as in the salmon (*Salmo salar*).

The stapeolus is the smallest of the otoliths, and is either rounded, subglobular, or furcate. The last-named form closely resembles the stapes, when, as in some animals, it wants the

base of the stirrup. A very remarkable instance is seen in the *Callichthys thoracicus*, or Demerara fish. The stapeolus is always enclosed near the anterior extremity of the otolithic ligament, and frequently firmly imbedded in its substance.

The appearance of the otoliths is very different in appearance from the bones of the fish; they have a porcellanus appearance, and quite distinct from the semi-transparent bones of the cranium.

The otoliths of the fresh-water are much more rounded and globose than those of the marine fishes.

As objects for the binocular microscope, none are more beautiful than these bodies; among them may be recommended those of the sprat, brill, smelt, anchovy, and grey mullet.

For sections those of the Pleuronectidæ may be preferred. It will be at once seen that the above observations do not at all agree with a paper read by Dr. Redfern before the British Association in 1859. In this Dr. Redfern says that "The otoliths of the cod, flounder, salmon, etc., are so similar in structure, that the one from the cod may be taken as the type." The author's specimens are so very dissimilar in every respect, that evidently some confusion must have occurred among the Doctor's specimens. The Pleuronectidæ (flounder) differ as much in their otolithic shape from every other as the salmon does from the cod.

Another of his observations is equally puzzling. He says (abstract Brit. Ass. Rep. 1859)—"The otolith" (for he only speaks of one) "when in position, appears to form one wall of an irregularly rounded cavity, from the interior of which the sonorous vibrations may be reflected, and thus affect the nerves." None of the author's dissections of the osseous fishes of more than 120 individuals support this statement. The central otolith of which Dr. Redfern speaks is freely suspended in the *midst* of the endolymph, and moreover is entirely surrounded by a membranous coat, which in many cases has to be slit open before the otolith can be obtained.

Fishes can do no more than be sensible of a noise. They cannot distinguish modulations or differences of tone.

One is reluctant to destroy a pet idea, however poetical and pretty, yet the searcher into scientific truths is often compelled to do so. It is so in this instance, for truth compels the assertion of the impossibility of the supposed fact that fishes delight in musical sounds, or come to be fed by the attraction of a whistle. The true explanation is, that the vibration of the footstep, not of the whistle, is the source of attraction. This may be proved by a walk along the margin of any canal or pond. Every one must have noticed that a footstep will instantly startle any of the finny tribe that may be lurking

under the grassy margin. On the other hand, if the observer be standing still, he may talk or whistle almost as loud as he likes, without the fish taking the slightest notice, provided he keeps himself and his shadow out of sight.

In reptiles we have creatures that partially or wholly live in the air, and therefore require a more sensitive arrangement for the reception of sound.

We here, for the first time, notice a *tympanic membrane*, but as yet no external orifice; for were the membrane exposed as in the mammal, sounds would be unbearable when in water, as before explained. It is, therefore, entirely covered by the skin.

The position of the ear may be readily seen in the frog, as a circular depression behind, and a little below the eyes. In these animals the otoliths change their character, and partly their office. The stapeolus here elongates into a long, sometimes trumpet-shaped body (columella). The other two otoliths, on the other hand, are much diminished, and are partially embedded in the fibres of the tympanic membrane.

The expanded extremity of the columella forms a kind of disk that closes the foramen ovale.

It is not a little curious that in the higher saurians and ophidians that a rudimentary cochlea may be observed, slightly conical in shape. This addition would most probably account for the impression which music is said to make on the serpent tribe.

The auditory organs of birds do not materially differ from those of the higher reptilia, except that in the former there is an external orifice, though small.

Some of the owl tribe have a rudimentary concha, but more commonly the external orifice is merely surrounded by a few feathers.

It is, however, in mammals that we reach the highest perfection in the construction of the ear. The mammalian ear is a sublime, yet simple, example of adaptation of a means to an end.

The external ear is now added, fitted with a funnel-shaped organ, and possessing a suite of muscles, and every appliance for the reception of the minutest sound. The cochlea, which we saw commencing in the highest reptilia, is now very complex, and enables the mammal to minutely distinguish one tone from another. The tympanic membrane is now fully exposed to the aerial vibration. The columella is now replaced by a series of small bones, which, as in reptiles and birds, connect the tympanic membrane with the internal ear.

The analogy between the otoliths and ossicula auditus has been often denied. It is undoubtedly true that the latter have

functions which the former have not; but at the same time it is equally true that all the offices of the fish otolith are performed by the mammalian ossicula. For besides the function of contracting, or otherwise, the tympanic membrane, they also, by their specific gravity, help to *intensify the vibratory influence*, and thus perform the part of otoliths. This fact it was, coupled with the number of bones or otoliths being nearly always *three*, that induced the author to give to the otolithic concretions their present provisional nomenclature. From the medusa to man so gradual is the transition from the true otolith to the ossicula of the mammal, that every step in the gradation may be found.

The question may now be fairly asked, What is the auditory arrangement of those animals that exist, as it were, in an intermediate state, and which partake of the nature or habits of two classes? It is a strange fact that the ear is still a constant mark of difference. For instance, the ornithorhyncus and kangaroo, which possess somewhat of the attributes of a bird, whilst they are undoubtedly mammals, actually possess the columella of a bird.

A still more remarkable instance is in the Cetacea.

It has already been mentioned that had aquatic animals the ears of aërial ones, they would be stunned by what we should call a slight noise. The whale, then, being a true warm-blood mammal, and at the same time living the life of a fish, how can it hear? The truth is, that the cetacean ear is a very wonderful combination of the ichthyic and mammalian organ. It hears, as it were, backwards, for the Eustachian tube opens into the blowhole, while the external orifice is nearly closed. The petrotympanic bone acts as a true otolith, while the mammalian ossicula and tympanic membrane are also present. When, therefore, the cetacean comes to the surface for air, it hears aërial vibrations through the Eustachian tube, while at the same time the otolithic ear is immersed, and cognizant of aquatic sounds.

The progressive steps have thus been briefly traced up to the beautifully constructed ear of the mammal, from the early condition in the medusa, when we first noticed an otolith, then the semi-circular canals of the fish, then the tympanic cavity of the reptile, and lastly the cochlea and external appendage of the mammal.

If the most profound philosopher had been requested to construct such an organ, what laborious calculations would he have made! what a complex set of mechanical contrivances! what a life-long study of acoustic and mathematical principles! and yet, after all, would undoubtedly have failed in accomplishing his purpose.

If a sceptic were to be watching the needle and scalpel, no investigation would be more conducive to admiration of a good and omnipotent Being, or one that would more convincingly conduct one's thoughts from nature to nature's God, and force the acclamation that—

"The hand that made us was divine."

A NATURALIST'S VISIT TO WALTON HALL.

BY THE REV. J. G. WOOD, M.A., F.L.S.

HAVING lately enjoyed another opportunity of examining at my leisure the unrivalled collection of preserved animals at Walton Hall, I hasten to draw attention to the marvellous success of the method by which they are mounted—a method so bold, so original, so utterly opposed to all recognized systems, and so apparently impracticable in theory, that actual inspection is needed in order to gain a true appreciation of so triumphant a result.

I take for granted that all readers of the INTELLECTUAL OBSERVER are acquainted with Mr. Waterton's *Wanderings*, and his subsequent volumes of essays, so that there will be no necessity for recapitulating facts which are already familiar to the reader. Suffice it to say that many years have now elapsed since Mr. Waterton announced his discovery of a process whereby the natural form of beast, bird, reptile, fish, crustacean, or even insect can be restored as in life, whereby it is made totally impervious to moth, mite, beetle, or any of the voracious tribes which devastate museums, and is inaccessible to "mould" in any form.

These were bold assertions to make, but more were to follow. It was furthermore asserted that specimens preserved in this manner could be cut up, removed piecemeal, and put together again without betraying a sign of their separation, that their weight should be less than that of the newly-flayed skin, and that no wires, woodwork, or internal support of any kind should be employed. I think that a more audacious plan was never originated, for the natural inference of such promise is that the skin shall be its own support, and shall, moreover, be so firm and strong that it will retain its shape even when cut to pieces, and be free from the slightest warping of the structure. It followed, also, that no stuffing is required within the skin, because if any substance had been employed for that purpose, it would have added much to the weight of the preserved specimen, and would have materially interfered

with the cutting-up and putting-together process which has just been mentioned.

Have these promises been fulfilled? Yes, and more than fulfilled. Time and experience, the two great teachers, have shown that to this process belong numberless advantages, and no perceptible disadvantages.

In the first place there is no unpleasant smell from the animals, every particle of it is placed beyond the power of decomposition, and as odourless as if it were carved from stone. No longer need the owner start with horror at the sight of a clothes-moth, a mite, or a dermestes, but with perfect unconcern he permits the creature to go its way, knowing that it has no more power to eat his preserved animals than to feed on the glass-case which protects them from the dust. That, indeed, is the only use of a glass-shade when you have such specimens, and excepting that dust, especially that grimy variety which hovers about the metropolis, is apt to collect on the fur and feather, and in time to dim their pure colouring, there is really no need for a case at all. Several large specimens at Walton Hall are without any protection, and many of the glass-cases are nothing more than five plates of glass fastened together at their edge box-wise, so as to cover the specimen, and protect it from the soiling touch of inquisitive hands.

Again, the specimens are far less obnoxious to injury by violence than if they were stuffed in the ordinary manner. Suppose, for example, that the Museum takes fire, and that the only hope of saving the specimens is to throw them out of window. I think that there would be sad havoc among heads, limbs, and tails of stuffed specimens, whereas the empty skins may be flung to any depth, and be none the worse for the tumble.

Throw a blown bladder from the top of a lofty house, and see what harm it takes; then put a series of wires inside it, together with a piece of wood, stuff it with tow and cotton-wool, and subject it to the same test. It will fall *rather* more rapidly and stop rather more suddenly, than if it were nothing but an empty membrane. Now, that is just the condition to which Mr. Waterton reduces his specimens, with this distinction, that when they are wounded they do not collapse. Indeed, he could take this same bladder, and in a wonderfully short time could give it permanently the full rounded outlines of its inflated condition, so that it would not alter its form in the least, though it were cut into twenty pieces. I have seen bare skins quite as thin and tender as the membranes of the bladder preserved in this fashion, and still retaining the plump roundness of the living form.

Indeed, to my taste, this art never shines out to more ad-

vantage than when dealing with naked skins. Whenever fur and feathers may be found, the preserver may cover his errors by means of "coaxing" the hair or the plumage, so that none but an experienced eye could detect the distortion; or additional feathers or patches of hair may be inserted, so as to hide the deficiencies. But when we come to deal with the bare skin, we find the severest possible test of our handiwork. No error can be concealed, and all shortcomings are glaringly prominent, so that the merest novice can perceive them. By this process, however, which really seems to rejoice at difficulties and to grapple with impossibilities, a triumphant victory is gained over the stubborn substance, which has successfully baffled all operators, save one, in their attempt to reduce it to submission. In the master's hand the bare skin is plastic as clay; he moulds it as he pleases, does what he likes with it, and, reversing the mythic fable of Pygmalion, he converts into statuesque rigidity the once active being, though, like that favoured artist, he inspires into the lifeless image the fire and energy of the breathing and living form.

See even the insects. We all know how insects are generally preserved; we stick a pin through them, we "set" them, we dry them, and when they are set we transfer them to our cabinet. If we have a large beetle which we wish to exhibit with opened wings, or if we set one of the fat-bodied moths, we are at a loss to prevent the abdomen from putrefying or shrivelling, or to guard it from the "grease" that damages so many fine specimens. Then, in order to keep off the mites and other destructive beings, we put a supply of camphor in the drawers, and think that we have done all that can be done.

But in this museum we have insects of various orders displayed as they are in life—walking, climbing, flying, feeding, or reposing, and all endowed with the peculiar attributes which they displayed in life. There is no camphor about them to condense gradually upon their surface like moisture on a cool glass, no pins are stuck through them, and their bodies are as plump and their colours as vivid as when they lived and breathed. Of the details I know nothing, except that a child can learn the process in half an hour; but of the results I can only speak with unmixed eulogy, having often tried my own hand upon such subjects, and having learned from my own failures how to appreciate such signal success in another.

People will scarcely believe me when I tell them about these wonderful specimens, and imagine that enthusiasm must have caused exaggeration; yet I have studiously restrained the words of commendation which would flow so readily from the pen, and, if anything, have understated the facts.

I have gone into the shops of professional "naturalists,"

and have been told that "Mr. Waterton's system is all a humbug, sir; nothing in it; it's as old as the hills. Corrosive sublimate is worthless, it spoils the colours and rots the feathers; nothing like arsenical soap," etc. Then, I have been told that no specimens can be prepared by that method unless every feather is perfect. Why, one of its chief characteristics is that it permits the operator to "make up" to any extent that he chooses, to substitute good feathers for bad, to remove a damaged limb and replace it by a sound one, and to make these changes without the possibility of detection. Then, I have been told that the specimens cannot endure damp, whereas they are expressly designed to resist the effects of moisture; and I have been informed that the corrosive sublimate has turned out a failure, and that the specimens are dropping to pieces.

They certainly were not dropping to pieces four days ago, and considering that forty years have elapsed since some of them have been preserved, and that it is impossible to distinguish between those which have stood in the museums for forty years and those which have scarcely occupied it for as many days, such specimens do not exactly look as if they are dropping to pieces. When a stuffed bird or animal is dropping to pieces, it cannot usually be taken up by a single feather or pinch of fur, and swung about without injury; nor will it endure crumpling and rude handling without losing fur or feathers in plenty. Yet I have seen specimens some thirty years old treated in that unceremonious manner, and without suffering the least injury.

We ask ourselves why a system which has proved itself to be so thoroughly successful should not be adopted throughout the kingdom? Why should we be doomed to see some of our most valuable specimens slowly perishing before us, while an infallible remedy is so near at hand? Why are we doomed to see such horribly unsightly objects as are presented by the stuffed skins in the museums, while a system has been in use for forty years which will reproduce the forms of the dead animals as they existed in life, giving even to the face, the nose, the lips, the ears, and all bare spots on the skin, the soft rotundity of the living texture? So wonderfully does this process restore the form, that even the peculiar tongue of the shoveller duck is seen in the open mouth, full, plump, and fringed as in life; and the webs upon the feet, and the little fleshy wrinkles about the eyes, are rounded, undulating, and to the eye as soft as in the living bird, though to the touch they are hard as horn. There is no doubt as to the success of the process, and the inventor is always ready to prove his assertions by pointing to his work. He does not merely say, "I can give to a monkey's skin the exact contour

of the living form, without the aid of wires or any internal support," but says, "I *have* done this; come and see it."

There was but one apparently valid objection to the system, and that is now removed. Professional taxidermists were accustomed to say that the process might be very well adapted for a gentleman of means, who had not to work for his living, but that they could not afford to spend six or seven weeks on the preparation of a single specimen. Now, in the first place, this objection is quite invalid, because it infers that each specimen requires undivided attention until it is dry, whereas it only needs a few minutes' work daily; so that, in fact, any taxidermist who wished to earn his livelihood by his art, could do so as easily as by the present system, by always keeping a number of specimens in hand. In the second place, since its first discovery the process has been greatly simplified and expedited, so that hours, or even minutes, will now do the work which formerly required weeks for its completion.

I write these lines, not to praise the inventor of a system which requires no eulogy, but to mention that it has been greatly simplified and improved; and to ask whether the art is to die with its originator. Will no skilful manipulator take it up? or are we to permit an art to perish which has produced such marvellous results as may be seen in the chimpansee, the peacock, and the eider duck in the museum at Walton Hall? I look upon the question as one of national importance, as affecting the character of our national collections. It is impossible to visit the museum at Walton Hall, and then to walk through the galleries of the British Museum, without feeling much humiliation at the contrast between what the specimens are, and what they might and ought to be. It is just as easy to prepare the skins in a right as in a wrong way, and if the former mode had been chosen, our national collection would long ere this time have assumed the pre-eminent position which we all wish it to attain.

THE BRISTLE-MOSSES.

BY M. G. CAMPBELL.

Amid the varied beauties of spring and summer, the ordinary observer overlooks many which, to the diligent investigator of Nature's secrets, microscope in hand, will afford sources of infinite marvel and ever new delight. Among these may be reckoned those dingy little patches of a brownish-coloured moss which compose the family of *Orthotrichum*, and are found growing upon trees, stones, and walls. As if requiring a nutriment less gross than common earth affords, they appear never to grow upon soil.

They are named from ὀρθὸς, straight, erect, and θρὶξ, hair; the calyptra being covered, in most of the species, more or less densely, with upright, hair-like processes, not matted into it, as in the *Polytrichums*, which we noticed in our May number. Unlike them, too, the capsule, instead of growing on a long seta, or fruit-stalk, is chiefly immersed in the leaves, or exserted on a short pedicel; while their comparatively small size and dingy appearance causes them to be frequently passed by as unattractive and insignificant, and *all alike;* whereas twenty-three species are enumerated by Wilson in his *Bryologia Britannica*, each sufficiently distinguished one from another. The *Bryologia Europæa* describes thirty-four; but we shall find enough to do with our native species at present.

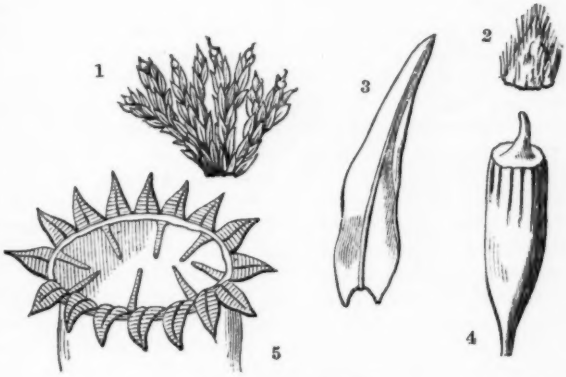
They ripen their fruit in the spring and summer, but the fruit requires twelve months to mature after the first appearance of the bud from which it originates. Thus, every month in the year presents some new phase of development. The inflorescence, though sometimes dioicous,* is usually monoicous, *i.e.*, the barren and fertile flowers are found on the *same plant*, though not on the same *receptacle*. To the latter form of growth the term *synoicous* is applied.

The *Orthotrichums* are perennial; their stems dichotomously, or *forkedly*, branched; their leaves are concave, keeled, nerved, and lanceolate, spreading from an erect base, the upper ones crowded into a small tuft, the lower ones more distant; when dry, twisted or curled, seldom straight, but remarkably susceptible of moisture; and, however closely imbricated or variously contorted in a dry state, immediately after contact with water they expand, and become more or less spreading. The barren flower in the monoicous species is either terminal or axiliary; at first in close proximity to the fertile

* From διοικέω, to live separate or apart; applied to such mosses as have the barren and fertile flowers on distinct individuals.

flower, but, as the fruit ripens, it becomes distant by the growth of the plant.

There is a sufficient resemblance in the members of the group to enable the student who becomes acquainted with one individual, easily to recognize the family likeness in other individuals of the tribe. The capsule is longitudinally marked with eight—sometimes, but rarely, with sixteen—coloured striæ, one British and a very few exotic species excepted. These striæ alternate with the teeth of the peristome, and in the dry state form prominent ridges. They consist of larger cellules than the other parts, and are more deeply coloured than those in the rest of the tissue of which the capsule is composed. When their number is more than eight, the intermediate striæ are shorter and unequal. The calyptra is large, campanulate, *i.e.*, shaped like a little bell, and the base somewhat torn into short segments. At a very early stage it is marked with furrows, but the hairs on its surface are not developed until a later period.



ORTHOTRICHUM RUPESTRE.

We give an illustration of *O. rupestre*, as typical of the genus. The illustration represents—Fig. 1, the moss of the natural size; Fig. 2, the calyptra, magnified; Figs. 3 and 4, the capsule and leaf, still more magnified; Fig. 5, the mouth of the capsule, very greatly magnified, showing the teeth and cilia, which alternate with and separate them into two couples between each pair of cilia.

Orthotrichum rupestre may be found growing in little tufts on rocks, chiefly in mountainous districts; hence its common English name, *Rock Bristle-moss*. The stems are loosely matted

together, elongated, branched, and decumbent* at the base; the leaves, when moist, spreading; somewhat recurved, lanceolate, and erect when dry; the capsule what is called *pyriform*, or pear-shaped, with eight faint striæ; calyptra campanulate, very hairy; teeth of the peristome apparently sixteen, in pairs, but really thirty-two, each apparent broad tooth consisting of a pair so connected as to seem but one; cilia eight linear-lanceolate. The capsule, when dry, is slightly ribbed on the upper part only. The spores are small and brown. The lid is convex, with a short beak. The calyptra yellow, and large enough to cover the greater part of the capsule. Fruit, ripe in July and August.

A more common species is the *Orthotrichum diaphanum*, or White-tipped Bristle-moss, which may be found on trees, walls, roofs, and old palings, growing in little patches; the stems loosely tufted and sparingly branched; the branches dichotomous, or forked; leaves almost piliferous, the acuminated point diaphanous and subserrulate; the capsule oblong, oval, half-immersed, pale yellowish brown, of very thin texture, and very obscurely ribbed. When dry, its little crimson, or sometimes bright scarlet lid, may be seen just peeping out of the leaves at the terminal points of the stem and branches. The teeth somewhat resemble those of *O. rupestre*, but the cilia between are sixteen, instead of only eight, and the calyptra is naked, or sometimes has a few scattered hairs of a pale yellowish-brown. The teeth, also, are spreading when dry; while in *O. rupestre* they are erect when dry. The accuminated slender diaphanous points sufficiently distinguish *O. diaphanum* from all others.

Another species is *O. crispum*, or Curled Bristle-moss, frequently found on trees. The leaves of this species are crowded, spreading, contorted, much twisted and crisped when dry; linear-lanceolate, ovate, and dilated at the base, slightly undulated; the capsule with a long, tapering apophysis imperceptibly passing into the short, thick pedicel, giving a narrow clavate, or club-shaped appearance to the fruit, which is widely striated, and contracted below the mouth. The inner peristome is composed of eight, sometimes of sixteen, cilia, which consist of a double series of cells. Spores brown and small; capsule not immersed in the leaves, but exserted on a short, coarse pedicel.

* "Decumbent (Decumbens, lying down) applied to stems when they recline upon the surface of the earth, but have a tendency to rise again from their extremities."—*Henslow Dict. Bot. Terms.*

THE PYCNOGONOIDEA (SEA SPIDERS).

BY GEORGE HODGE.

(*With a Tinted Plate.*)

THE generality of persons who have devoted any time to researches in marine zoology must at some time or other, during their shore-hunting and dredging expeditions, have come across one or more species of Pycnogons—possibly *Pycnogonum littorale*, *Phoxichilidium coccineum*—or even some of the less common *Nymphons*. We, however, hear very little about them, and it would appear they are very imperfectly understood, judging from the statements made in the scanty literature of these animals.

Little has been done in this country towards cataloguing the native species, or unfolding their life-history. They have, in most cases, been hastily passed over, either as unworthy of a lengthened description, or as being of an obscure tribe, little understood, and little cared for by those for whom information on allied animals was written. This is to be regretted, for it has had the effect of retarding the progress of observation on the habits and singular economy of these animals, and, further than this, it has, in a great measure, led to the often-broached discussion of their true position, which would not long remain unsolved were their life-history clearly made out. It is singular that, whilst other animals have been most diligently studied, and the advance in the knowledge of the habits and minute anatomy of obscure animals is something marvellous, we find the *current* information relative to the Pycnogons little advanced during the last eight or ten years.

By some authors they are considered as being closely allied to the *Arachnida*, as opposed to those who maintain they are a low grade of crustacea. Dr. Leach placed them amongst the former, forming an order for their reception, which he named *Podosomata*, but he subsequently "became so perplexed with doubts and difficulties relative to this family's relationship to other animals, that he dissevered it entirely from the system, and threw them into an appendix."*

Even at the present day they are differently placed by different authors—a most unsatisfactory state of things.

They are pretty generally diffused, being alike brought from the Arctic, Atlantic, and Pacific seas. It would, however, appear that they are more especially inhabitants of a cold or temperate sea; possibly the Scandinavian waters have produced more species than any other locality. Their size varies con-

* *Samouelles' Ent. Comp.*, 305. London, 1819.

siderably, some being only one-eighth of an inch in greatest span, whilst others attain as much as eight inches from the tip of one limb to the tip of the opposite—the dimensions of a specimen of *Nymphon gigantea* from the Shetlands, in the possession of Mr. Spence Bate.

The most striking peculiarity noticed in a Pycnogon when first seen, is the extraordinary dimensions of the legs, and the small size of the body—the latter, in most cases, being a short segmented tube, little thicker than the limbs at their origins. This body, or thorax, is divided into four segments, by means of three constrictions—the first, or anterior segment, carries the rostrum, oculiferous tubercle, first pair of legs, palpi, and foot-jaws when present, and in the case of the female the false feet; the two next segments carry the second and third pairs of legs, whilst the fourth or terminal carries the fourth legs and abdomen.

The rostrum consists of a blunt rounded organ, perforated at the free end, and through which the animal imbibes nourishment. The precise method of alimentation is not clear, but judging from the character of the œsophagus, which appears to be furnished with cilia, it is the opinion of the writer that a current is produced by their action which carries the food into the gullet.*

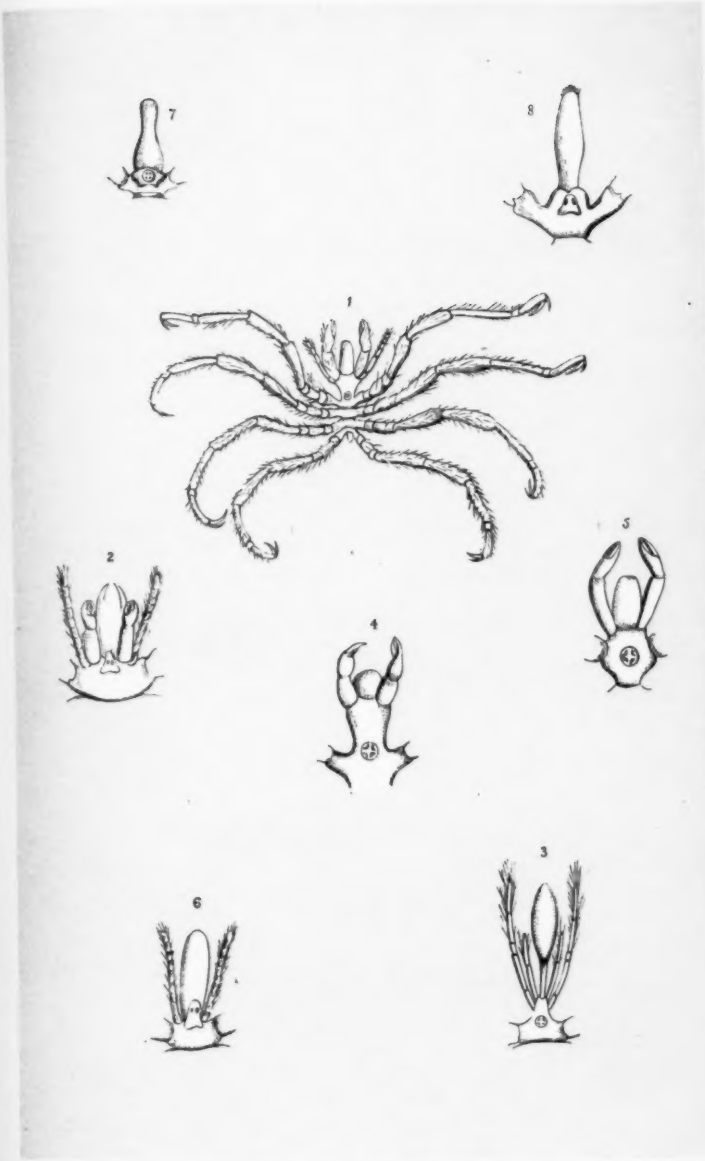
The length of the rostrum varies in different species; in some cases it exceeds the length of the foot-jaws, and in other instances it is much shorter than these appendages.

The foot-jaws are represented by two strong nipper-like organs, the office of which it is difficult to determine. Any one examining a *Nymphon*—for example, *N. gigantea*—would be likely to consider them connected with the procuring and conveying of food to the mouth or orifice of the rostrum, in the same way as a crab uses its fingers. Such, however, has not been noticed in the Pycnogons; and when it is remembered that some genera are destitute of foot-jaws, and others have them so placed, and of such dimensions as to render their use for that purpose impracticable, it may fairly be surmised that their office must be otherwise accounted for.

The palpi consist of two filiform appendages, varying in length and in the number of joints.

The oculiferous tubercle is a wart-like protuberance, more or less elevated, and varied in shape, according to genera and

*The food of these animals has not been satisfactorily determined. Fabricius was of opinion that they preyed upon the soft parts of Bivalved Molluscs. The writer has frequently taken *Pycnogonum littorale* upon Actinæ. In one instance, a specimen of *P. littorale* was found with its rostrum firmly embedded in a small specimen of *Bunodes crassicornis*, which it was evidently preying upon, the "crass" showing its dislike to its visitor by the emission of a large number of "nettling-threads."



Pycnogons (Sea Spiders.)

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species, and having at the upper, or free end, four dark coloured spots, usually of a crescentic form, which represent the eyes.

The true legs, of which there are eight, are eight-jointed, the terminal joint being usually furnished with one strong and two small claws. The false feet, or "egg-carriers," of the female are produced from the under-side of the anterior segment of the thorax, usually near the origin of the first pair of legs; they generally consist of five to ten joints, the last three or four being provided with leaf-like setæ of curious form and structure, near to which the egg masses are found attached.

The abdomen, which resembles an elongated wart, either one or two jointed, is attached to the *upper* surface of the fourth segment of the thorax. Compared with the thorax, it is a mere rudiment of the organ represented, and in this respect contrasts most forcibly with the Arachnida, in which the abdomen is a prominent feature.

The Pycnogons generally are more or less furnished with bristles, either in the form of hairs or spines; in some species the latter are so large as to have given a character by which to distinguish them.

Returning to the legs, and their great disproportion to the other organs and parts, the surprise must be rather increased than abated, when it is stated that the food when taken into the stomach freely passes into the legs, as far as the sixth joint; in fact, the alimentary canal is not confined to the body alone, but sends out prolongations, termed cœca, into the legs, and also into the foot-jaws when present. During the movements of the animal, the food contained within these cœca is forced into that part of the stomach which is contained within the thorax, the pressure thus exercised forcing particles of partially digested matter into the cœca of other limbs. The food, during the continual motion thus imparted to it, is seen to undergo digestion, the residue being finally expelled through the abdomen.

The manner in which the biliary fluid is produced and applied is unknown; it would, however, appear that as the digestive system of these animals is of a peculiarly degraded type, we must not expect to find any special apparatus for the purpose.

The females only differ from the males in the possession of the false feet before alluded to. The generation of these animals is unknown, and it is even doubtful whether any author has hazarded an opinion of the mode in which the eggs are fertilized. All we know is, that at certain seasons they appear upon the false feet of the female, and from being at first filled with a mass of granular matter, they gradually change their

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character, and develope into embryos as unlike their parents as can well be imagined, showing that they must undergo some wonderful metamorphosis before they attain the characters of the adult individual.

The larval state of several species has been figured and described by Kroyer* and others, but their development into the perfect animal is involved in much obscurity, for with the exception of a series of observations made by the writer on *Phoxichilidium coccineum*,† there has been no published record of the several changes they must go through in attaining the adult form.

The circulation and respiration of the Pycnogons have at different times occupied the attention of several naturalists. Amongst the number Quatrefage,‡ who published an elaborate paper. He, however, failed to make out anything particularly conclusive, and whilst he did good by bringing together scattered observations, he did harm by stamping with the authority of his name certain views which have proved entirely erroneous. From the observations he made upon a species of *Phoxichilus*, he arrived at the conclusion that there was no regular circulatory system; an opinion since contradicted by Zenker,§ Krohn,‖ and Williams,¶ and which any one can readily demonstrate by the careful manipulation of a suitable living specimen, which is seen to possess a dorsal vessel, serving the purpose of a heart, with its sets of valves. The current of fluid, or blood, traverses the thorax and limbs by a series of pulsations, usually forty in a minute, the stream flowing with considerable regularity, unless it meets with any opposition, as the doubling of a leg, which disturbs the circulation of that part alone, the loss of time being made up by redoubled speed when the stoppage is overcome. Tracing the current from the dorsal vessel *upwards*, we find it urged towards the rostrum; when near its apex, it branches out at right angles, and flows over the under surface of the thorax to the several limbs, which it enters at their upper sides, and courses up as far as the last joint, returning by the opposite side to the dorsal vessel, which

* "Note sur les Metamorphoses des Pycnogonides," in *Ann. Sciene Nat.* 2 Ser. Zool. tom. 17, 1842, pp. 288—292.

† "Observations on a Species of Pycnogon (*Phoxichilidium coccineum*), with an attempt to explain the Order of its Development. By George Hodge. *Annals and Mag. of Nat. Hist.* January, 1862.

‡ "Mem. sur l'Organization des Pycnogonides," in *Ann. Sciene Nat.* 3 Ser. Zool. tom. 4, 1845, pp. 69—83.

§ "Zenker, Wilh. Untersuchungen über die Pycnogoniden," in *Müller's Arch. f. Anat.*, 1852, pp. 379—391.

‖ "On the Heart and Circulation in the Pycnogonidæ." *Annals and Mag. Nat. Hist.* 2 Ser., vol. 16. 1855.

¶ "Dr. T. Williams on the Mechanism of Aquatic Respiration in Invertebrate Animals." *Annals and Mag. Nat. Hist.*, vol. 13, 1854, p. 300.

it enters by the valvular opening near the origin of the limb.

This plan of circulation may serve a twofold purpose, for not only may the ordinary restoration of tissues be effected thereby, but at the same time the corpusculated fluid may receive the necessary æration, which the absence of any regular set of organs for the purpose would demand. Accordingly we find the outer surface of these animals is studded with innumerable little warts, and these under a high magnifying power are seen to contain minute openings, or pores, through which a simple cutaneous respiration is effected by contact with the surrounding sea water.

The presence of a distinct nervous system is readily noticed, consisting of four large "centres" seated on the *under* side of the thorax, one in each segment; the anterior communicates with the brain, foot-jaws, etc., with the former by means of two bands uniting immediately beneath the oculiferous tubercle, which is the seat of the brain, and with the foot-jaws by two similar bands, one to each. From each "centre" also proceed two nerves, which pass into the legs, and, according to Quatrefage, divide into two or more bands shortly after entering the limbs.

The Pycnogonoidea are divided by systematists into two families, *Nymphidæ* and *Pycnogonidæ*. The former contains Nymphon, Ammothoa, Zetes, Pallene, Phoxichilidium, and Pasithoe, and the latter Pycnogonum and Phoxichilus.

These various genera are most readily distinguished from each other, each possessing characters peculiar to itself. The several species are, however, difficult to name, for although the characters of each are pretty constant, the differences perceptible to the ordinary observer are very slight, excepting in a few cases; the genus Nymphon, in particular, is very puzzling, and it is only by an extensive series that the various species can be named with certainty.

The characters by which the genera are determined are thus stated by Dana:—

Nymphon.—Antennæ two branched, the one thicker and furnished with fingers, the other five-jointed. Front scarcely narrower at the base. Abdomen one-jointed.

Ammothoa.—Like Nymphon, but the larger branch of the antennæ nine-jointed.

Zetes.—Antennæ having two slender branches. Front much narrower at the base. Abdomen two-jointed.

Pallene.—Antennæ with one branch, which is furnished with fingers, moderately thick. Abdomen one-jointed. First (egg-bearing) feet eleven-jointed.

Phoxichilidium.—Like Pallene, but first (or egg-bearing) feet five-jointed.

Pasithoe.—Antennæ with only one slender branch, unprovided with fingers.

Pycnogonum.—Feet short; egg-bearing feet ten or eleven-jointed. No antennæ.

Phoxichilus.—Feet very long and slender. No antennæ.

The foregoing generic characters, taken in connexion with the plate accompanying this paper, will enable any one to refer such specimens as may be obtained to their proper genera; and as the season for sea-side trips is nearly here, the present is a fitting opportunity to direct the attention of those in want of a novel study to the animals in question, and it is a subject that cannot fail to reward the painstaking observer.

Explanation of the figures.—Fig. 1, *Nymphon hirtipes.* Fig. 2, Rostrum, foot-jaws, palpi, etc., of *Ammothoa robusta.* Fig. 3, Rostrum, palpi, etc., of *Zetes hispidus.* Fig. 4, Rostrum, foot-jaws, etc., of *Pallene brevirostris.* Fig. 5, Rostrum, foot-jaws, etc., of *Phoxichilidium coccineum.* Fig. 6, Rostrum, palpi, etc., of *Pasithoe vesiculosa.* Fig. 7, Rostrum, etc., of *Pycnogonum littorale.* Fig. 8, Rostrum, etc., of *Phoxichilus spinosus.*

THE CAVE OF BELLAMAR.

BY GEORGE E. ROBERTS.

Of late years caves have been explored rather upon palæontological grounds than physical, and those which have yielded bones to the naturalist have ranked higher than that more numerous group, the stalactitic and stalagmitic, products of which only enrich the cabinets of the mineralogist. But if palæo-zoologists have a special greeting for bone-yielding caves, the interest of the physical geologist remains fixed upon those larger caverns, formed by various agencies in the material which envelopes the ball of the earth. Some have resulted from chemical forces, like those subterranean caverns upon Etna, formed, as Sir C. Lyell has taught us, by the induration of the lava during the escape of great volumes of elastic fluids; and others from phenomena of ice-and-water action, as exampled in the "ice-vaulted wildernesses" described by Dr. Wallich as lying beneath a glacial covering in Greenland, wherein we may fancifully suppose Necks, and other genii of the thick-ribbed ice, have their abiding place. Or, again, we have the better-known class of caverns typed by the marble grotto of Antiparos, the now smoke-dimmed glories of which appear to be far eclipsed

by the wonderful beauty of the newly-discovered cave to which I am about to direct attention. This cave is situated in a limestone hill two miles from the bridge of Bailen on the San Juan River, near Matanzas, in Cuba. No reliable intelligence as to the geological age of the rock has reached England, but the hill is probably a point in the range south-west of Matanzas, described by the Baron von Humboldt as a compact lithographic limestone, and called by him "Calcaire (Jurassique?) de Guines," an adoption, probably, of its local name.

Cuba is almost a *terra incognita* to the naturalist; perhaps, with the exception of Madagascar, no country has been so little studied; yet it must be a very paradise for beauty, and for the number and variety of its natural productions. No less than 374 species of ferns are met with upon the island, and in molluscan and zoophytic fauna its shores are exceedingly rich. Scarcely any description of these has yet been attempted, and until the Spanish Government places greater facilities in the way of travelling naturalists, we can hardly expect to hear much of its natural wealth. Perhaps the most important geological observations upon Cuba are those contained in a paper by Mr. R. C. Taylor (*Phil. Mag.*, July, 1837). In describing the Savana in the north-east part, he speaks of some "white limestone mountains," which may be of older geological age to the rock which contains our cave. The Savana is dotted with what appear to be "snow-white basaltic pillars," formed however of this limestone, and shaped of course by water-action. The effect of these, says Mr. Taylor, shooting up like enormous crystals among the dark green foliage of a tropical forest, is equally grand and singular. This limestone forms massive hills in the eastern part of the island, and exhibits extensive fissures, which afford hiding-places to the numerous wild dogs which infest the country. The most remarkable of these hills is the one called La Silla, a honeycombed mountain of white limestone, a bare and nearly perpendicular rock, about 1200 feet high, which rises like a huge group of snow-white crystals. About 150 feet below the summit is an extensive suite of caves, which were explored to the depth of 300 feet by Mr. Taylor and his party. The interior of one is said by him to resemble an Anglo-Norman crypt, having a heavy groined roof, and pillars of constantly-increasing stalactite. A thick layer of "cave earth" concealed the floor, and was found to be mainly composed of the exuviæ of bats, mixed with myriads of land-shells. This was fast hardening into a bed of shelly carbonate of lime, being aided in the process by the stalactitic droppings from the roof. Elsewhere in the mountain, fissures were seen by Mr. Taylor to be entirely filled up with an analogous deposit of more ancient date, but which contained the same

genera of land-shells and some bones of the cave-rat, being, in fact, an osseous breccia, nearly allied in appearance to those of Gibraltar and Malta.

Similar caverns to those of La Silla, though of younger geological age, have been described by Captain Nelson (Proc. Geol. Soc., vol. ix. p. 205) as occurring in "coralline crag rock" at Long Cay and Rum Cay, in the Bahamas, and as containing like organic remains. Basset's cave also, in the Bermudas, which extends inland from the sea-wall for nearly a mile, is of the same recent origin; and so, too, was the pretty little cave at Tucker's Island, with its sparry-fretted ceiling, which had to be destroyed, as it lay in the line of works ordered for the Bastion. From another cave in the Bermudas, having no apparent entrance, a Mr. Anderson obtained specimens of a breccia, made up of bird-bones and land-shells, cemented by stalagmite, which are now in the foreign collection of the Geological Society.

The cave of Bellamar, which, if the accounts given are reliable, must certainly be the queen of West Indian caverns, was accidentally discovered by a quarryman opening up a deep well-like rent in the rock, which proved to be the entrance.

The little guide-book published by Señor Manuel Santos Parga, owner of the property, gives the following description of it:—"The first, or entrance hall of the cavern, has been named the Gothic Temple, from its vast and severe beauty, reminding one of the solemn nave of some ancient cathedral. It is 900 feet in length by 240 wide; in parts the roof is 60 feet in height. Magnificent stalactitic pillars adorn it, drooping from the roof to the floor; the largest of these measures 60 feet in height, and has a width varying from 8 to 21 feet. The stalactitic droppings have simulated in it the appearance of a giant mantle, with stately and capacious folds. Beyond this immense chamber lies the Gallery of the Fountain, a corridor 2400 feet in length! In the centre of it is seen the spring which gives its name, hemmed in with the loveliest stalactites. Walls, roof, and floor are alike invested with a crystal robe of the purest and most glittering white. At the end of the long gallery the traveller comes to a fine arch called the Devil's Gorge, a few yards beyond which the stalactites and stalagmites are commingled so as to form one vast screen of transparent alabaster. One of the gems of this charming group is called the Embroidered Petticoat, being a beautiful hollow stalactite, as smooth as marble, three feet in height, and having a symmetrical edge, six inches wide, made up of large crystals. But perhaps the most dazzlingly beautiful of these cavern-halls is the smaller one named the Hall of the Benediction, which lies still farther from the cave's mouth and

deeper in the mountain. It obtained its name from a blessing having been pronounced upon it by the bishop in a moment of enthusiasm. This is a chamber of unsurpassed beauty. Floor, walls, and vault are alike of the purest white; slender columns of stalactite covered with thousands of small crystals form aerial vistas, or droop pendent from the roof like the most fanciful combinations of Eastern art. One of the most striking of these, a large stalactitic mass, which falls like a transparent cascade with an undulating surface, has been named the Mantle of the Virgin. From beneath it issues a stream of water, the source of which lies deeper among the yet unexplored recesses of the cave. Still farther we come to the Gallery of the Lake, remarkable for the stalactitical mass called the Snow Drift, and this is at present the terminal point reached. The Lake of the Dahlias, which hides some marvellous crystallizations in the form of those flowers, stops farther progress. Returning through the Hall of the Benediction to the Gallery of the Fountain, the visitor turns into a side passage near its centre, and traverses Hatuey Gallery, named in honour of an Indian chief, famous in the early history of Cuba, by reason of a slender, well-proportioned stalactite, which stands like a chieftain's lance, beneath a high vault. Here is also a lovely group of these fairy-like productions, called the Closet of the beautiful Matanceras; and another resembling a canopied niche of the richest Gothic tracery. Many of the stalactites possess the property of double refraction, and occasionally the crystallizations are tinted with the delicate hues of the violet or rose, or shine with the rich lustre of gold."

The cave of Bellamar runs from west to east, and attains a maximum depth of 360 feet. The temperature is in no part beyond 80 deg. Fahr. As may be expected, it has become, from its proximity to the wealthy and populous city of Matanzas, a place of great resort, and the owner evidently reaps no small advantage from the show. The entrance fee charged is a dollar for each person. For this guides and lights are provided; in addition to which the visitor finds good paths through it, fixed lights at the chief points, and small bridges thrown over places which need them. An excursion through it takes from two and a half to three hours. I have not heard that any natural communication with the surface exists, but no scientific exploration of it appears yet to have been made.

BEACH PEBBLES.

BY S. M. SAXBY, R.N.,

Principal Instructor of Naval Engineers, H.M. Steam Reserve.

About a dozen years since a noble invalid was sent by his physician to seek in the Isle of Wight that retirement which the necessities of impaired health demanded. Whatever repose the body might have sought on the luxurious couch of shingle which nature provides so amply in some parts of that favoured island, the habitual activity of mind so well known to distinguish the individual referred to, soon found an interesting exercise in examining the shingle itself. But who could have expected the result? It is enough to assert that, in the hands of the noble lord and two accompanying members of his family (and under my own roof too, where I had the resources of my laboratory at hand to test any specimens of which I had doubts) I saw nearly every gem known to the lapidary; say about 500 specimens, all of which had been found in the shingle at the back of the island, within a range of about four miles of coast line. Add to this the result of my own subsequent researches in that and various other parts of the shore, and we have the indisputable fact that a hitherto neglected source of amusement exists of which not only the ordinary pleasure-seeker but the convalescent or invalid can avail himself in such localities.

My object is to show how best to do it.

It is not, for the present, necessary to adduce geological theories as to the origin of these beds of shingle, for it is easy to conceive that the various changes which have, through ages, altered the land surface, would, from the abrasion and destruction of rocks of every kind, present occasional accumulations; and these collections of *débris* would be seen to advantage were the softer portions removed by the action of water; and especially the harder crystalline substances, which are found in the remains of the older and unstratified rocks, would in such accumulations be thrown together as we find them. The gems of the lapidary are of the latter description.

In searching a shingle-beach, it should be borne in remembrance that all real gems (the opal excepted) will scratch window-glass; also that (with the same exception) no gem fit for the purposes of the lapidary has a specific gravity less than that which forms the bulk of the shingle-beach; consequently hardness and specific gravity form the principal tests to be used in determining the quality and value of specimens.

Every fragment of stone having transparency or translucency is worthy of examination. Every piece exhibiting colour differing from the ordinary stone which forms the bed is worthy a place in the pocket until leisure at home determines its name and worth. The most brilliant gem owes its beauty either to repose after its formation as a crystal, or to the skill of the lapidary, who renews the surface after abrasion among other stones. Hence shining fragments among the rolled and rounded stones of the beach are not to be expected. Constant attrition renders even the choicest rock crystal apparently translucent. The same applies to other substances; as an example, I have in my collection one of the most handsome of "moonstones." I found it on the shore at Bonchurch, Isle of Wight. Doubtless many precious stones are cast aside from want of this consideration, especially with young collectors. It was only when I dropped it into water in a test tube and used the pocket lens, that its peculiar *chatoyance* was detected. Of course, the lapidary's care soon revealed its great beauty, although the specimen is only one-sixth of an inch long.

And further, the finest beryl or aqua-marine, when found on the beach, might easily be mistaken for a piece of green glass bottle; indeed, fragments of green and blue wine bottles have been an abundant source of disappointment and annoyance to the collector; but mistakes of this sort are easily avoided by breaking a flint and trying its sharp angle against the supposed treasure, for if it be glass, the flint will scratch it, whereas a beryl will slightly mark flint.

As found in the beach, the finest blue sapphire would be but a darkish dingy-coloured stone. The brightest emerald, which is scarcely harder than flint (being indeed a green beryl) is, in its rough state, a dull, almost opaque-looking greenish stone.

It may be admitted, as a general rule, that the clearer a stone or crystal from the shingle-bed is seen to be, the harder and more valuable it is likely to prove on further examination.

But even were the choicer gems totally unknown to our coast, enough may be collected in the members of the quartz family itself to create a pleasant source of lasting interest in the examination of a shingle-beach; and this will appear plainly from the few hints and descriptions which follow.

The great difficulty with those who collect stones is to know under what names to rank them. Quartz (which is pure silica) enters so largely into the composition of rocks, and is seen under such varieties of aspects and combinations, that no other class of minerals can furnish a like amount of interest and even usefulness; for the beauty of some of its combinations is scarcely to be surpassed by anything in nature. Our attention will therefore at present be given to a few general descriptions

which may assist examinations on the shore, rather than to scientific arrangement and details.

Almost every watering-place has its local "diamonds." Ventnor, Bristol, Brighton, etc., have long been noted for the purity of the pieces of rock crystal found in their sea-beaches. As most of these, when discovered upon the shore, have lost the characteristic form of their original hexagonal prism, it is only by superior specific gravity and hardness of the diamond that an ordinary observer can distinguish the difference.

It is best to select the half tide, or "half beach" portion of the shore for examination, for there the shingle is commonly shallower, and the bottom of the bed, as well as the surface of the underlying sand, are more easily accessible, and it is *the* place at which gems in particular are likely to reward the seeker. It is even well and advisable to examine the upper inch in depth of the sand itself.

Under the terms quartz, carnelian, chalcedony, jasper, and agate are to be found every variety of the family we have under consideration; and attention to the following distinctions of character will enable any one to name and arrange specimens for the cabinet.

Mineralogists have adopted ten substances (represented by numbers 1 to 10) as tests for the hardness of minerals; but, on the beach, it is enough to be provided with a piece of common window-glass, the comparative hardness of which is about 5 to 5½ in the scale used in works on mineralogy; and also with a piece of felspar, which is the flesh-coloured crystalline substance found in common granite, and it represents a hardness of 6; also a piece of flint, which has a hardness of 7 in the same scale; but in testing, care should always be taken to ascertain from which of the substances brought into contact the streak is obtained, for at times it is not easy to determine. It is best to remove the dust from the streak in order to see if the testing mineral has really left its mark from having cut the surface.

Specific gravity is easily ascertained by weighing a specimen first in air and then in water (in the latter operation the object, if small, may be attached by a little piece of bees'-wax to a hair fastened to one scale, and then allowed to dip into a tumbler of rain-water); on dividing the weight in air by the loss in water, the quotient will be the specific gravity, water being considered as 1. The use of bees'-wax will scarcely affect the result, because it is nearly of the same density as water. With small specimens it is necessary to weigh to tenths of a grain. These weights are easily procurable, and greater accuracy is seldom necessary for the purposes of the pebble collector.

A very ready method of distinguishing quartz crystals from a large number of others, is by trying if they can be scratched with a knife. Steel will not scratch quartz; and further, quartz crystals generally show a horizontal striation or striping on some faces of the hexagonal prism (at right angles to the longer axis of the crystal); they will moreover strike fire with steel.

As to the varieties of quartz, one has a peculiarly dark green colour, and is called "prase." Milk quartz is a translucent variety, owing its milky colour to a metal, and we can generally in it detect a slight reddish tinge. It differs from chalcedony in not having a blueish tinge. Where the shade of red is very distinct, the specimen generally has more transparency, and is then known as rose-quartz.

A very elegant variety, of a yellow colour, is the well-known Cairngorm. It much resembles topaz, but wants both the hardness and specific gravity of that beautiful gem. The specific gravity, for instance, of quartz being 2·6 to 2·7, while that of topaz equals 3·4 to 3·6. The hardness of quartz being 7 in the scale, and of topaz 8.

The mineralogist does not limit the term "amethyst" to quartz of any particular colour, but uses it broadly as indicating coloured varieties of semi-transparent quartz. Popularly the word designates a kind which is tinged of a delicate violet from the presence of manganese.

Brown quartz is valuable for the cabinet; many pieces, however, which appear to be of this colour, have only a deposit of oxide of iron upon the surface, removable by dilute hydrochloric acid. Quartz of a smoky tinge is often mistaken for beryl, but the latter has generally a peculiar horny yellowness as seen in the play of reflected light about the sides of the stone when held in certain directions. The beryl will, moreover, scratch quartz.

There is a beautiful stone which incloses minute fibres of asbestos, producing, when polished, a resemblance of flickering light, as seen in the cat's eye; this is only a fibrous variety of quartz, but is much prized. The difference between "cat's eye" and moonstone is simply this—the cat's eye has fibres in quartz, but the moonstone has them in felspar, which is a composition of quartz, alumina, and potash.

We often find the hollow flints lined with a pale bluish translucent substance, having what mineralogists call a "botryoidal" surface, like that of an aggregation of soap bubbles (or the surface of a bunch of grapes); this is chalcedony, and very handsome pieces are met with in shingle. Sometimes, in cavities, the chalcedony has in form much the appearance of icicles or a "stalactite." Layers of coloured chalcedony occur in

nature, and where such are straight or only slightly curved, the stone is called "onyx;" and in this figures are carved out of one layer, leaving another of a different colour as a background. Such carvings are the well-known "cameos." Stones in which an opaque white alternates with a deep or orange brown which is tolerably translucent, are called the "sarde onyx;" and in the estimation of the lapidary, the more translucency, the greater the value. "Sarde," itself, is a very beautiful and frequently met with variety of quartz, of an orange or amber yellow, or more commonly of a reddish yellow, and is only semi-translucent. Some specimens when moved in certain directions, possess in a considerable degree that beautiful play of light already referred to as *chatoyance*, and much resemble opals of the same colour, but are both heavier and harder. The richest shore for variety in this species of stone is the back of the Isle of Wight, from Niton to Bonchurch, although larger and elegant specimens of some sorts are obtainable between Walmer Castle and Sandown Castle, at Deal. What is known as "plasma" was formerly used in making ornaments; it is dark green, having lighter coloured spots. (Its specific gravity is only slightly above 2·0.) Bloodstone, or heliotrope, is a fine well-known variety of chalcedony, tinged green with chlorate, and has irregular dots and markings of bright blood-red jasper. A very pretty apple-green quartz is called chrysoprase; its colour is not uniform, but clouded, and the stone has considerable translucency.

The difference between chalcedony, carnelian, jasper, and agate, is often scarcely appreciable. The name carnelian was originally given to specimens of a flesh colour, but it is now extended to the brown and yellow varieties. Numbers are brought from the East Indies, but very beautiful specimens are found on the beach at Deal, and especially near Deal Castle, and opposite the dockyard. Carnelian is never figured nor striped; the deep, clear red is the most valuable for the purposes of the lapidary.

When layers of chalcedony, instead of being straight or nearly so (as in onyx) are suddenly interrupted by angles or sharp curves, the stone itself having some considerable translucency, such are termed agates, and many are of great beauty. They are never perfectly transparent. A general characteristic of agate in its rough state, is the resinous or waxy appearance of its fracture, while that of quartz resembles more the glitter of broken glass.

Scotch pebble is agate of an agreeable reddish tint, free from cloud or mark, and is semi-transparent. When without small flaws, to which it is very liable, it polishes into a handsome stone of good surface. When agate contains mossy or

branched internal markings, it is known as moss agate or mocha stone.

In some parts of England whole masses of agate rock are composed of layers of chalcedony or milk quartz in small but intricate convolutions; when these layers are of some dimensions and present angular flexures, they so much resemble the bastions of a fort, that the name "fortification" agate has been aptly applied to them. At St. Just, in Cornwall, this rock may be seen *in situ*.

The mixture of iron with flint or quartz gives it a considerable change in appearance, causing an opacity characterizing the bulk of fragments which form a shingle beach; and such is jasper. The prevailing colours are red and yellow, but it is also found of a deep rich brown, or even nearly black, and sometimes green. The bright pure yellow and the light scarlet are the most prized, although the latter seldom occurs except in small portions, but it is very elegant. Coloured layers are known as ribbon jasper; and when these layers are concentric, the stone is called Egyptian jasper, the yellow generally occupying the central portion of the stone. (All the varieties of quartz receive and retain a brilliant polish.)

A singular combination of quartz and water forms the "opal." A trace of water is detected in quartz, but in opal it amounts to as much as 10 per cent. Hence the lighter specific gravity of this mineral as compared with quartz, while its hardness is about that of window glass. The varieties of opal are sufficiently hard to be found among shingle. One is the "cacholong," of a milky white, and nearly transparent, distinguishable from milk quartz by its opacity and by its slightly adhering to the tongue. The "noble" opal is a very elegant gem, having colours combined in flashes of delicate lake, blue, and yellow. When the red greatly predominates it is termed "fire" opal. Common opal is abundant as fossil wood, and on some coasts may be procured in pieces of considerable size; it is easily detected by its showing the grain of wood, and being too hard to be scratched by a knife.

The only specimen of "felspar," besides the moonstone already mentioned as a constituent of granite, and worthy of present mention, as liable to occur in shingle, is the "Labradorite," a greyish or dull greenish stone, very slightly translucent, but when broken, and especially when polished, showing a pleasing iridescence. Like quartz, it takes a high polish.

The "smoke" beryl is found on almost all the south coasts of England, even so far round as Garrison Point, Sheerness. It slightly exceeds the quartz in hardness, otherwise it might easily be mistaken for opal.

This short summary of objects in shingle would be incom-

plete without mention of another subject, which requires the use of the pocket lens. For example, if we examine some localities we shall find rounded flints having perforations in various directions, not through the stone, but into it; on breaking some of these, the interest and curiosity are deeply attracted by the frequently found, perfectly well preserved and petrified remains of exquisite corals, sponges, etc. Indeed, the needle-like spicula of sponge are often in these nodules seen of the greatest conceivable delicacy.

Indescribably beautiful specimens of what the late Dr. Mantell called the "choanite," are obtainable in some beaches. If you find an oval, flattish stone with generally a rough exterior, having its roughness (on close examination) caused by minute, short curved lines, suspect the presence of the choanite; lay the stone in the hand (protected by a glove, handkerchief, or any soft body) and strike the specimen at the middle of the thinner and longer edge of the oval, with a small hammer. One or two smart taps will split the stone through its longest section and thus reveal the interior, the wetting of which will render it more plainly visible. There is no limit to the colour, and variety, and form of these beautiful fossil polypes. I believe Sandown Bay, in the Isle of Wight, to be the richest deposit in England of this remarkable class of objects; they are there met with in that beach of the size of three, four, or five inches in diameter.

DR. WALLICH'S AMŒBA VILLOSA.

BY HENRY J. SLACK, F.G.S.,

Member of the Microscopical Society of London.

My object is to lay before the readers of the Intellectual Observer some account of Dr. Wallich's *Amœba villosa*, a remarkable Rhizopod on which three papers have appeared in the *Annals of Natural History*, and which I have had some opportunities of examining myself. I hope that by thus directing the attention of a wide circle of microscopists to this curious creature it may be sought for in other localities, and its history still further explained.

In conformity with the view adopted in the notice of the "Protean Animalcules" in the Intellectual Observer for February of this year, Dr. Wallich expresses his belief that the *Amœbæ*, respectively named *princeps*, *diffluens*, and *radiosa*, are mere transitory phases of one and the same species, their dif-

ferences being of shape rather than structure. With the new form, which he designates *villosa*, the case is altered by the constant presence of a particular organ not found in the other kinds, and which marks a decided advance in specialization. The organ in question consists of a tuft of villi, capable of varying in length and breadth, but never disappearing except as an optical result of the position the creature may assume. The aspect of the *Amœba villosa* may be seen from the accompanying drawings, and those hitherto observed are mostly larger than the better known kind, some of them "attaining a diameter of not less than $\frac{1}{50}$ of an inch."

Dr. Wallich originally discovered this species in Lower Bengal in ferruginous pools, and when rambling over Hampstead Heath, behind Jack Straw's Castle, his attention was excited by numerous pools and puddles of a similar kind, the sediment in which disclosed the form of his old Indian acquaintance. The pools in question contain much flocculent matter, apparently of vegetable origin, strongly coloured by peroxide of iron. At some seasons they exhibit little animal life, and I had been so often disappointed with them that at the very time when Dr. Wallich was collecting his specimens, I warned some brother collectors that they were of no use. I mention this fact to show the necessity of never giving up any situation as hopeless, unless it has been tried under all varieties of season and weather.

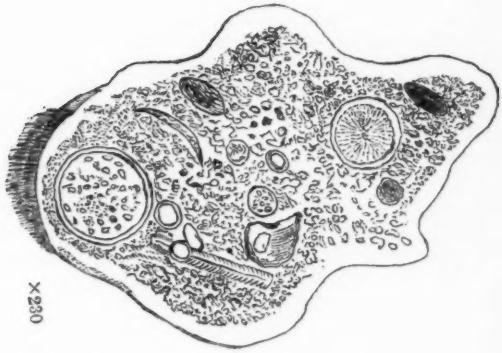
When I read Dr. Wallich's first paper I expressed my desire to see the new creature, and he was so obliging as to show me some of his own specimens, and to give me a few from his then waning stock. In March he found them plentiful, in April less so, and by May they became exceedingly scarce, and soon disappeared. When plentiful they were associated with diatoms, chiefly pinnularia, and swarms of Crumenulæ and other coloured members of the Monad family. Fine specimens presented a beautiful appearance from being crammed full of these objects of food, which preserved their natural colours, and glistened with brilliant tints of emerald green, and various shades of orange, red, and brown. The voracity of the animals was extraordinary; there seemed no other limit to their appetite than the capacity of their whole bodies to take in and hold the miscellaneous subjects of their choice. Those which I saw were not very active, being, as Dr. Wallich explained, far less so than others which he had previously obtained. Without any noticeable structural change they grew languid, put out a multitude of small thin pseudopodia from various parts of their bodies, and finally died. When in better health their pseudopodia, as seen by me, were always broad, moderately long, and with blunt rounded tips.

XUM

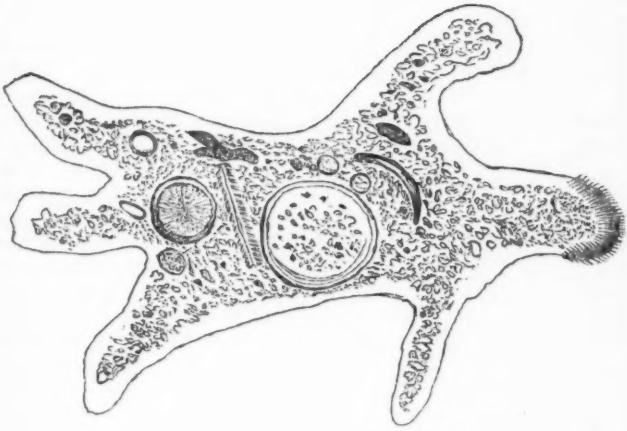
The peculiar organs were either like a group of little fingers, or shrunk to slender dimensions. In the accompanying drawings they are represented almost as fine as cilia, which was often the case with my specimens, but they were very susceptible of enlargement and motion. At times I noticed a smooth rounded outflow of the so called ectosarc, or outer layer, not at all like pseudopodia, but transparent, free from granules or food particles, and similar in shape to the curved patterns which an advancing tide forms during a calm on a flat sandy shore. When this took place there was the appearance, but not as I imagine the reality, of a distinct and separate film dividing the food-holding and thicker portions of the animal from the thin outflow which I have described. Had the outflow continued and been resisted by the thicker part, a solution of continuity and rupture must soon have resulted; but when the tension of the expanded portion reached a certain pitch, it strongly compressed the thicker part, and then a current of sarcode carrying food particles flowed into it. Dr. Wallich, who devoted amazing patience to these creatures for many hours a day during three months, speaks of their having a motion of "reptation" or creeping, which my limited opportunities did not allow me to see distinctly, but the ordinary flowing mode of progression characteristic of the *Amœba* was often shown. Dr. Wallich likewise noticed that the villous organ was sometimes employed as an instrument of prehension; and it was remarkable in his specimens and in mine that no important pseudopodia were projected either from the villous patch or from the sarcode in its immediate vicinity. I often saw *small* pseudopodia in its neighbourhood, but they were insignificant both in size and in any use the creature made of them.

For want of sufficient specimens I could not obtain opportunities of getting drawings of the nucleus and contractile vesicle, although I occasionally caught a glimpse of them. It was very easy in many specimens to mistake some round objects of food for the nucleus, but Dr. Wallich was so fortunate as to observe and draw many nuclear bodies in a mulberry condition, and to examine them, after their extrusion from the animal. The villous patch is capable of being thrust forth from the general mass upon an elongated pedicle, and it is in some way curiously connected with, or acted upon simultaneously, with the nucleus and vesicle. Dr. Wallich says,* "I have had ample opportunity of verifying the observation that in the majority of specimens, so long as the villous patch is being employed as an organ of prehension, and not merely dragged along in rear of the main body, the nucleus and contractile

* *Annals Nat. Hist.*, April, 1863.



AMŒBA VILLOSA.



vesicle retain their position in its vicinity, but that they circulate with the other contained matters whenever the prehensile action of the villi is in abeyance." From his various observations it would appear that there exists "some kind of consentaneous action between the contractile vesicle, the nucleus, and the villous area." In a few instances he saw a delicate tubule perforating the villous patch, through which minute particles were ejected. The ordinary progress of the creature is *from* the villous patch *forward*, so the villous organ is dragged behind. In my specimens it was often temporarily obscured by an overflow of the adjacent sarcode.

Another important characteristic which I had no means of observing, is thus described by Dr. Wallich, who says, "One of the most remarkable amongst the novel and varied characters of these *Amœbæ* consists in the vesicle in which the true nucleus is contained, having been found to be distinctly membranous in mere individuals." This fact the Doctor verified by examining nuclei isolated from the main body by means of the compressorium. This observation relates to single separate nuclei, and he adds, "In contradistinction to this the multiple nuclei had neither inverting membrane nor nucleolus. Can it be that the one phase represents the germ cell and the other the sperm cells?"*

A very important question raised by Dr. Wallich relates the distinction which has been made between the ectosarc and endosarc in these creatures. In one of the papers referred to† he came to the conclusion that "the ectosarc and endosarc are not permanent portions of the Protean structure, but mutually convertible one into the other, and that it is an essential feature of sarcode that whilst the outer layer becomes, *ipso facto*, instantly differentiated into ectosarc, the same layer reverts to the condition of endosarc under the circumstances just described;" "these circumstances" being "the projection of the ectosarc from the general surface, in the form of a hemispherical mass, with a broad base, only a very small portion of the original contour line seeming to give way at first, so as to admit of the passage of the endosarc and other granular contents into the newly projected part, but its entire floor appearing to be gradually dissolved, as it were, and free communication between the main body and the new pseudopodial cavity not being established until the completion of this process." This theory has a high degree of probability about it, and if confirmed must modify the ideas entertained concerning the differentiation exhibited in ordinary *Amœbæ*. Experiments with reagents are very liable to the misconstruction arising from the difficulty of distinguishing between what they reveal and

* *Annals Nat. Hist.*, May, 1863. † Ibid.

what they make, and it is conceivable that a substance like sarcode should exhibit different properties when in contact with water containing air, to those which it possesses when all its particles are secluded from direct contact with water, but are bathed by the internal fluids of the creature, and surrounded on all sides by other particles in precisely the same state. Dr. Wallich does not, however, consider that the villous patch is permanent in its condition; on the contrary, he conceives that a slow and constant interchange of protoplasmic matter takes place there as in other portions of the body. He regards the *Amœba villosa* "as bridging over the hiatus between the true Rhizopod and true infusorial organization." The principal distinction of the latter consisting in possessing distinct organs for the inception and extension of foreign matter, and in there being "no convertibility of parts once established."

Dr. Wallich also considers that he has established with regard to these *Amœbæ* the fact of viviparous reproduction, the young ones being from $\frac{1}{2,500}$th to $\frac{1}{1,000}$th of an inch long, and exhibiting nucleus, villous tuft, and contractile vesicle. I should add that he found in several specimens extremely minute crystals of rhomboidal figure, and soluble in muriatic acid.

In conclusion, I may state that my specimens of the *Amœba villosa* were very uneven in surface, from the multitude of objects that had been taken in by the gelatinous mass, but were not sufficiently engulphed to leave it smooth. That a creature of such low organization should range from Bengal to Hampstead will excite no surprise, but it would be interesting to ascertain whether the presence of oxide of iron is necessary to its existence, or, in other words, whether it is confined to ferruginous pools, which may be its exclusive habitation, although their colouring matter did not impart the slightest tinge to those which I saw.*

* Since writing the above, I learn from Dr. Wallich that he has found the *A. villosa* at Streatham. He adds that he is more and more satisfied that all the different forms of *Amœbæ* are transitional phases of one and the same organism, of which the *A. villosa* is the highest state of development.

WHAT IS INSTINCT?

BY SHIRLEY HIBBERD.

M. FLOURENS has added to the long list of books bearing his name one on Instinct and Intelligence,* in which he reviews with some care the opinions of all the great authors who have written on the subject, and supplements those opinions with suggestions and deductions of his own. We cannot award M. Flourens any high praise, either for originality or profundity, but we would be content to gather from his pages any useful items of information, and thank him for obtruding upon our attention a most interesting subject, could we do so without suffering the vexation of seeing logic superseded by sophistry, and truth made the slave of human pride. But M. Flourens follows very faithfully the example set him by the authors he reviews. It is perhaps a hazardous proceeding to utter a general condemnation, but we fear it is but too true that the only honest writers on this subject are those who take the most ridiculous views of animal instinct and intelligence. For instance, Descartes in his *Discours sur la Méthode*, denies animals the power of thought, on the ground that they do not possess the faculty of speech. He says, "Although beasts do many things as well, and perhaps better than one of us, they infallibly fail in many others," by which, he says, it may be inferred that "they do not act from knowledge, but only by the disposition of their organs." "It is a remarkable thing," he says, "that there is no man so stupid, excepting only the insane, who are not capable of arranging together divers words and composing a discourse; but, on the contrary, there is no other animal, however perfect, that can do the like, and this not only proves that beasts have less reason than man, but that they have none at all."

Buffon is equally honest, and almost as absurd. He admits that brutes have sense and feeling, and also that they have a consciousness of their actual existence, *but not of their past existence;* they have sensations, but no power to produce ideas. Upon these grounds Buffon denies that animals are capable of thought, reflection, and memory, yet he avoids the extreme view of Descartes, that they are merely vitalized automata. "Condillac is right," says M. Flourens (p. 41), "when he says if beasts invent less than we, if they perfect less, it is not that they fail entirely in intelligence, but that their intelligence is

* *De l'Instinct et de l'Intelligence des Animaux.* Par P. Flourens. Paris Garnier Frères, 6, Rue de Saint-Pères.

more limited. But he is wrong when he says that is by a sort of invention, that is to say, because he *compares, judges,* and *discovers* that the beaver builds his cabin, or the bird constructs his nest, and therefore all his theory upon the faculties of animals is vicious, because he confounds the things which are essentially distinct, namely *instinct* and *intelligence.*" The most entertaining of all the disquisitions on this subject is undoubtedly that by Lord Brougham, in the *Dialogues on Instinct,* wherein he takes care to put down all the sage remarks to his own credit, and makes Lord Spencer responsible for statements most easily refuted. In this delightful book numerous examples of (so called) instinctive operations are described and analyzed; but in spite of the noble author's manifest desire to be liberal and just, it is but too evident he is influenced by what Smellie, in the fifth chapter of his *Philosophy of Natural History,* designates "mistaken notions concerning the dignity of human nature." To sum up this bibliographic note, without reference to many less distinctive opinions, we must notice two other attempts to solve the riddle of instinct, if only for the purpose of showing what opposite opinions may be entertained of the same subject. Father Bougeant, a learned Jesuit, in a tract called *A Philosophical Amusement Concerning the Language of Birds and Beasts,* affirms boldly that animals are capable of thought and reflection, and to escape all the difficulties arising out of "mistaken notions concerning the dignity of human nature," contends that the actions of animals are entirely the result of the influence of evil spirits, that in fact the brute creation is under the dominion of the devil. On the other hand the great Newton considered that all animals were under the immediate operation of the Deity, and that consequently their instinctive and intelligent actions were alike the expressions of divine impulses.

The definition of instinct commonly subscribed to is that it is a blind impulse, that it acts without knowledge either of the means employed or the effect to be produced. With all their professions of dissent from Descartes, the majority of definers, with Lord Brougham for leader, have concurred in his opinion that animals are like clocks, the Creator has wound them up, and they must continue as long as their races last, accurately, unchangeably, and ignorantly, in the course of action first appointed them. Brougham classes instincts as physical and mental. Physical instinct, he says, is independent of mind altogether, and mental instinct is independent of reason altogether. The example generally chosen is unquestionably the most difficult, no matter what prejudice we lean to, or however perfect may be our freedom from bias of every kind. We are called to examine the work of the honey bee. Here are hexa-

gonal cells, which afford a maximum of strength, and consume a minimum of material. They terminate in rhombic dodecahedrons, they incline at an uniform angle, so that the liquid they are constructed to hold shall not escape, and they are arranged in the hive so that between every double set of cells there is sufficient space for traffic between them. There can be no dispute as to the general accuracy of the work, and as to the fitting together by proper relationships of all the events and operations incidental to the life and industry of the hive. But we may reasonably dispute the fairness of instancing the work of the bee as an example of blind, untaught, objectless instinct; for this simple reason, that all the evidence for such a view is of a negative character. Brougham sums up the matter thus:—"Laying aside those actions of animals which *show a glimmering of reason*, and confining ourselves to what are purely instinctive, as the bee forming a hexagon without knowing what it is, or why she forms it, my proof of this not being reason, but something else, and something not only differing from reason in degree but in kind, is from a comparison of the facts, in a word, from induction. I perceive a certain thing done by this insect, without any instruction, which we could not do without much instruction. I see her working most accurately without any experience, in that which we could only be able to do by the expertness gathered from much experience. I see her doing certain things which are manifestly to produce an effect she can know nothing about, for example, making a cell and furnishing it with carpets, and with liquid, fit to hold and to cherish safely a tender grub, she never having seen a grub, and knowing nothing of course about grubs, or that any grub is ever to come, or that any such use, perhaps any use at all, is ever to be made of the work she is about. * * * In all this she differs from man, who only works well, perhaps at all, after being taught; who works with knowledge of what he is about, and who works intending and meaning, and in a word designing to do what he accomplishes. To all this may be added, though it is rather perhaps the consequence of this difference than a separate and substantive head of diversity, the animal works uniformly and alike, and all his kind work alike; whereas no two men work alike, nor any man always, nay, any two times alike. Of all this I cannot indeed be quite certain, as I am of what passes within my own mind, because it is barely possible that the insect *may have some plan or notion in her head, implanted as the intelligent faculties are;* all I know is, the extreme improbability of it being so." Now although this theory of instinct has been generally assented to, we do not hesitate to challenge it, in the belief that we shall be able to prove that it is of the

same species of sophistication as the quibble of Zeno, that a man cannot walk a mile.

First, we will submit it to a test which may always be applied with fairness, that is, we will apply the author's conclusions a little more extensively than he has done himself. The bee makes a hexagon without knowing what a hexagon is, or what it is for, though she herself is to fill it with honey or pollen, and seal it up when filled. Ergo, the bee visits a flower without knowing it is a flower, she extracts honey without knowing it is honey, or that honey is her proper food. She flies through the air to some distant place without any expectation of finding there the flowers that yield honey, and she goes to a place she has much frequented, and which abounds with flowers which yield honey plentifully, without knowing she has been there before, and in fact without intending to go at all, and without any idea of what she will do when she reaches her destination. She returns to the spot she started from without knowing that it is the spot, or that she is a member of a community, or that her interests are identified with the bees composing that community, or that there is a community or any such thing as another bee in the world besides herself. Indeed, we do not see that she need know even of her own existence, if she is so fatefully mechanical as to build and furnish a cell without knowledge of what it is, or any forecast of its future uses. If we accept the first hypothesis, we cannot refuse the second; if we invent premises, we must follow them to their ultimate consequences. It is not long since we heard a schoolmaster argue thus:—"Brutes have no soul, therefore they cannot reason. The elephant is a brute, therefore it is only a vitalized machine; it cannot reason."* We can scarcely avoid classing the excercitations of Lord Brougham with those of our syllogistic friend; in fact, of the two we prefer the latter, because the sophistry is delightfully apparent.

Now as to the proofs. Who can say that the bee does not know why she forms a hexagon? When we observe that bees quickly select the best honey-producing flowers, as, for instance, mignonette, spergula, bramble, Dutch clover, salvia, nemoralis, etc., etc., to the neglect of others which furnish little honey, we applaud their sagacity, and say nothing about blind impulse. We know of no impulse to direct bees to lime trees in such numbers that their humming oftentimes alarms the passer-by, nor do we know how mere instinct should cause

* The person whose words are quoted above enjoys an enviable fame as a trainer, and has been most successful in his vocation; that is, measuring success by the number of his pupils. It would be cruel in this connection to publish his name.

them to neglect the garden, when they have choice of the more odoriferous flowers of the moorland. She is allowed to know what honey is, and to distinguish between good and bad honey; she is granted the faculty of distinguishing a rose from a cabbage, and the bee master from an intruder, of detecting a robber bee upon the threshold, and of recognizing the presence or absence of the mother of the hive; but when her work intrudes upon the domain of mathematics, we are startled from our propriety, and at once forget our former conclusions of the capacity of the bee to observe, remember, and reflect, and suddenly insist that she is doing something in utter ignorance of what she is doing, or that she is doing anything at all. The researches of Maraldi and Torre on the work of the bee have literally nothing to do with the question of instinct, for it cannot be contended that because the work of the bee is mathematically perfect, that therefore she must be as ignorant of her own work as a clock is that it is recording the true time.

"I see her working without any experience," says Brougham. It is a gratuitous assumption that the bee has no experience. It is quite possible that bees inherit experience as man does, for it must be remembered there is an experience of the race as well as an experience of the individual. But let us look at the facts. Dr. Bevan and other authorities concur in the opinion that the worker bee lives from six to eight months. Mr. Taylor, the author of the best book on bees, adopts this view. In the course of twenty-one days from the laying of an egg by the queen bee, the egg has been hatched, and the worm has completed its last metamorphosis. An individual bee, therefore, may witness the birth of *nine or ten* successive generations of workers in the course of its lifetime, and transmit the experience gained thereby to those successive generations by a process of teaching. But putting aside the possibility of teaching, here, at least, is experience, which it is so essential to deny on the theory of instinct being a blind, objectless impulse. But this is not all. Mr. Desborough, of Stamford, set himself to work out a solution to the question, how long does the queen bee live? and the writer of this saw all the apparatus used by Mr. Desborough, and believes in the soundness of the conclusion arrived at, that the same queen continues active and fertile during a period of *four years* at least; how much longer she endures Mr. Desborough was unable to ascertain with certainty. It is surely as reasonable to conclude that the experiences of bees are of use to the community as the experiences of men, and seeing that they have abundant opportunity for acquiring experience, we prefer to believe that they work by knowledge rather than adopt a theory which derives no support from observation.

It is equally an assumption that the bee works uniformly, as it is almost a falsity to say that men work diversely. If a hexagon fulfils the conditions of a given case, and there is no other form that will fulfil those conditions, then there must be a hexagon whether the worker be bee or man. A broad view of human affairs will show that man is as much the slave of impulses and blind instincts as the bee, if we are to admit impulses and instincts at all as separate from actual knowledge. The philologist tells us that all languages are easily reducible to a few elementary forms. The ethnologists say that there is very little diversity in the fashion of human habitations, and our present experiences tell us that in all our works of art we draw upon the past, and are much more occupied in repeating what has been done than in inventing things unattempted yet! Even in the domain of literature there are but few primary ideas: all the Greek epics and tragedies were framed out of the same half-dozen stories, and at the present day there is no nobler form of verse known than that in which Homer sang. Granted that men do work diversely, though to a much less extent than is generally supposed, so does the bee. A newly-hived swarm works with more vigour than the population of a well-stocked hive. If the work of the bee be interrupted, there is an immediate adaptation to the new circumstances of the case, and when a disaster happens there is a speedy resort to new methods of procedure, either to avert its worst consequences or to repair the damage the community has sustained. As to the alleged perfection of the works of the so-called blind instinct, that is the most gratuitous assumption of all. The work is not uniformly perfect, but frequently very imperfect, and in this respect exactly parallel to the occasional aberrations of acknowledged intelligence. For instance, bees will sometimes collect pollen in such prodigious quantities as to prejudice their own well-doing, and lack honey for their own use while heaping up bread superfluously for a small progeny of young. What becomes of the theory of instinctive perfection in the face of such a fact as this? Yet it is very like the occasional mistakes of men, as when a ship laden with leather boots puts into a port where the people are starving for want of bread, or, as in the case of the Crimean war, green coffee was sent to men who had neither fires to roast nor mills to grind it. Were the instincts of bees so perfect as they are represented, we should never witness examples of the queen dropping eggs at random, because there are no cells to receive them, nor should we see in honey boxes that the first combs were often so badly placed that in the end the bees had to fill up odd nooks and corners with twisted and triangular patches, which are at any time significant comments on the theory of instinct infallibility. Pro-

bably Lord Brougham and many other learned writers on instinct never had to shift a few stocks of bees from one place to another in a garden, or to hive swarms, or take boxes of honey, else we might have heard much less about the alleged uniformity of procedure and invariable perfection of results. What is the instinct which prompts bees to a savage exercise of their powers to wound and poison when molested?—do they not know what they are doing? and have they no object in pouncing on the marauder? If they sting the man who takes the harvest so carelessly that they discover the trick before it has succeeded, is it not fair to conclude that they know they are being robbed, and avail themselves of the means of punishment with which nature has furnished them?

We have argued this case on the basis of the mathematical theory of bee economy. Respecting this theory, there are two things to be said. First, it is not true; secondly, it demands so much of the bee that it compels the adoption of a false theory of instinct. Error and folly are boon companions; the supposed mathematical accuracy of the angles of cells required us to believe that the bee had learnt, without teaching, what a large proportion of human beings could not learn with teaching, or to account for the whole affair by supposing the insect to be under a mysterious power, the attempt to define which made it more mysterious. Notwithstanding Brougham's remark, that "there is no bee in the world that ever made cylindrical cells," it is very certain that the bee makes nothing else, and that hexagons and rhomboids are alike the result of pressure, and represent the angles of equilibrium between the pressure and the resistance, just as the orbits of the planets are the midway lines between centrifugal and centripetal forces. The insect is not such a mathematician as has been generally supposed, and, therefore, when it is demanded for bees that they know somewhat of the nature of their work and its intended uses, all that is asked is to allow them as much intelligence as is needful for the construction of simple cylinders of the same size as their own bodies. It is true we have not now accounted for the fact of their working to a common plane, or for the ordinary disposition of cells on either side of that plane, by which a double comb is produced. These certainly appear to be instinctive operations, but they are of that kind which Brougham admits "show a glimmering of reason," and if there be a glimmering anywhere, we know for a certainty that there somewhere near at hand light is to be found. In the *Annals of Natural History*, of June, 1863, will be found an analysis of the mathematics of the beehive, by the Rev. S. Houghton, in which the theory of the bee forming hexagonal cells is completely overthrown. We owe it to our friend Mr. W. B. Tegetmeier that we were long ago

convinced that bees make cylindrical cells, and as we have seen those cells in formation and can generally find some in the outer portions of removed comb, there is no other course left us but to ascribe to the laws which control inanimate matter the mathematical wonders which have been made the basis of a sophistical theory of instinct.

We have spoken decisively as to the utter ignorance of the bee in mathematics, and the difficulty of the hexagonal cells is annihilated. We have room to say that the alleged economy of material is as great a delusion as the other. We owe it to Mr. Houghton that our attention has been called to the investigation by mathematicians of the relation of expenditure of material to the mathematical requirements of connected cells of given dimensions, and of a form adapted to the uses to which they are to be put. L'Hullier, in 1781, using MacLaurin's method, arrived at the conclusion that the economy of wax referred to the total expenditure is $\frac{1}{51}$st, so that the bees can make fifty-one cells instead of fifty, by the adoption of the rhombic dodecahedron. But L'Hullier maintains that mathematicians can make cells of the same form as those of the bees, which, instead of using only a *minimum* of wax, would use the *minimum minimorum*, so that five cells could be made of less wax than that which now makes only four, instead of fifty-one out of fifty. But suppose, again, that we grant the alleged economy of wax, we only get out of one difficulty for a moment to encounter a greater, the moment the theory of a mathematical instinct has been propounded for general purposes. Say the hive bee has attained to perfection in her work, what, then, of the humble bee? Is she to be shut out from a participation in this wonderful instinct, or shall we grant her the higher faculty of reason, and so account for her abuse of the laws of geometry, as we see in humble bees of the human race, who frequently waste timber, stone, and other materials, through ignorance of leverage and the nature of strain in constructive operations? Certain it is that the humble bee uses, proportionately, more than three times the amount of material in the construction of cells than is used by the hive bee; and if the hive bee is so far from attaining to the ultimate possibility of perfection in the economy of wax, how should the humble bee excite our pity and give occasion for the theorists to lament that facts are against them! Nature has not commissioned these insects to teach men mathematics, nor has she commissioned men to deny them a share of the same intelligence which, in human affairs, vindicates its existence in a great measure by its errors.

But this will suffice, perhaps, for the present about bees. We have said so much only because this is the favourite example

of the theorists who contend for a mental instinct, and limit it by boundaries furnished out of their own imaginations. M. Flourens institutes a categorical inquiry into all the mental qualities of animals, and, up to a certain point, very satisfactorily. Let us, adhering to his method only as far as may be convenient, glance at some of these qualities as we see them manifested. It is admitted, even by the automatists, that animals have a consciousness of their existence, but then they say they have no power of thought. "How," asks Flourens, "can they have consciousness without knowledge, and knowledge without thought?" What is consciousness but knowledge, and what is knowledge but retained impressions and ideas? "They have *no memory*. What! this dog, which *distinguishes*, that is to say, *recognizes* the places he has lived in, the streets in which he has run; who has been corrected by chastisements, who seeks for the master he has lost, who goes and dies upon his tomb,—this dog has *no memory!*" It is a smart jump from the bee to the dog, and it is a jump we make, and not M. Flourens. But when we are confined to a brief summary of arguments, extreme cases are best, and the bee offers an example of the extreme one way and the dog the other. Now let us compare them. They have no speech, says Descartes, and there are foolish people of the present day who join with him. Then the whine of a dog at the door on a cold night does not imply that he wishes to be let in. The deep bay of the mastiff when there is a sound of a strange footstep at night is not to be understood either as a warning to the master, or a threat to the thief, or an expression of the dog's suspicion that all is not right, it is only a fortuitous sound, the result of purely physical causes, and may rank with any of the sounds produced by inanimate nature. But perhaps there will be no dispute as to the speech of the dog; but it will be asked has the bee speech also? We answer *yes*. The writer of this has had bees under his observation daily for a period of over fifteen years, and could bring forward examples to illustrate every requirement of a theory of insect intelligence were it needful, and would space permit. But one instance will suffice. A bee, whom we will call A, is entangled in a spider's web; he has been liberated and placed on the floor-board in front of the hive. Another bee, whom we will call B, approaches, and exchanges with the victim of Arachne a few passes of the antennæ. B immediately enters the hive, and presently returns with two others, C and D. B, C, and D then commence cleaning A of his entanglements, and in so doing get somewhat entangled themselves with the glutinous threads. Every now and then there is a pause, and all of them engage in bringing their antennæ into mutual contact, and occasionally after one of these conferences, a new

method of cleaning is tried; and the end of it is, that the object of their solicitude, A, is at last purified of his spidery pollutions, and all enter the hive together, and we see no more of them. The observer concludes that they made communications to each other on the subject of A's troubles, and by mutual agreement determined on his release from bonds, and the cleansing of their own persons of the defilements he had unavoidably fastened upon them. If a man were entangled with ropes, and his comrades consulted how to release him, and eventually succeeded, we should not describe the act as the working of a blind impulse, or of an instinct which neither knew what it was doing, nor what was the object of its labours; why then should we degrade the bee by denying that she has knowledge, or attempt to prove her deficiency of knowledge by hazarding the assertion that she is incapable of speech?

What is Instinct? We could not attempt to answer this question until we had first done something towards clearing away the absurdities of theorists who trusted more to syllogisms than to observation, and to fancy rather than to fact. What are called physical instincts are no doubt very often, but not always, "independent of will or mind altogether." About these we will not raise a question. But mental instincts appear to be of the same nature as reason, directed with intensity in a narrow channel. It is an instinct of the bee to collect honey. We must grant that it knows what honey is, and what honey is for, and by so far the act of collecting is the act of reason. But it is pursued with such ardour, that it becomes the fixed habit of the insect, and a habit may be followed so mechanically, that it may on a superficial view appear to be but a blind impulse, and to be performed without knowledge. But no matter how strong the force of habit, if, initially, it is the result of an act of reasoning and the expression of a *motive*, and is followed for *a purpose*, then it can never be separated from mind; though when the habit is fixed, it makes little or no demand upon the mind until some exigency arises demanding a deviation from habitual rule. Let the reader reflect upon any habit of his own, as that of reading without noticing the individual letters of words, without thinking at all of the rules of punctuation and pronunciation, without perceiving at all the minute relationships of words to each other, and occupying the mind only in following the thoughts of the author, and the act of reading will appear to be purely instinctive. Yet we know it is not, and have never considered that men were machines simply because of their capacity for literary pleasures. Test the comparison by reference to any other act which is performed habitually, as the motion of the foot in turning the lathe when the mind is wholly directed to the action of the cutters, and

how much like what we call instinct in animals is the effect of habit in ourselves. How the bee first acquired the art of extracting honey from flowers, and building comb from wax, we know not; the inquiry into that matter must have its place in the general inquiry as to the beginnings of all things; but we much rather believe that her work is the result of intelligence and performed with knowledge, and capable, up to a certain point, of improvement by experience, and, in a word, the result of reason modified by habit, than an ignorant and, so far as she is concerned, purposeless endeavour to accomplish an end which she neither foresees nor has any care about.

It may be said that after all we have only exchanged one word for another. Such is not the case. We have no objection whatever to the employment of the word Instinct, provided it be no longer considered as something independent of mind. We would rather regard it as the proof of mind, and as something impossible, except as a mental product, or, as we have said above, the work of mind rendered tolerably uniform by habit. Let us illustrate this.

Every distinct breed of dogs has peculiar instincts. A thorough-bred shepherd's dog will take to sheep with scarcely any teaching, but a dog of any other breed will require very careful training to be able to take care of sheep, and then be but a bad sheep dog. The instinct to protect sheep is initial in the individual sheep dog; but if all dogs are from the same stock, it must be a habit transmitted, not an aboriginal instinct. In fact, so far as we understand the dog, its pure instinct would lead it always to worry and never to protect sheep. There is no breed of dogs that will follow game by scent with the steadiness of the hound; but if the following be an instinct, why is the pointer deficient of it? The answer seems to be, that in the first instance the hound has been taught, his mind has been informed, and the knowledge gained thereby is transmitted to his offspring, just as Sir John Herschel has inherited from his father a taste for astronomy, and has followed it by the light of reason and not by the light of instinct. Terriers and spaniels will hunt by scent, but they will not *pack* as hounds will, and hounds undoubtedly pack because they run at large game, and one individual would be insufficient to cope with it. A well-bred pointer will point at game the first time he sees it, and need scarcely any teaching beyond such as is necessary for obedience to calls and such like minutiæ. Sir John Sebright, in his *Observations upon Instinct*,* expresses an opinion that "the greater part of the propensities that are generally supposed to be instinctive, are not implanted in animals by nature, but that they are the

* Published by Gossling and Egley, New Bond Street, 1836.

result of long experience, acquired and accumulated through many generations, so as in the course of time to assume the character of instinct." Whether we accept this opinion as sound, or reject it altogether, we must tacitly consent to it whenever it is our object to produce a breed of animals required for any active purpose; and in dogs especially the breeder will prefer cleverness before beauty, and in choosing a sire ask first about his performances, in the full expectation of a progeny capable of exhibiting superior ability.

All our knowledge is relative, and it is therefore vain to seek for a perfect theory of the intellectual powers or a definition of instinct utterly unassailable. But it is not difficult to perceive, that in harmony with the development of form, so is the development of mind—there is least of both in zoophytes and insects, and most of both in man. But it is a violation of the law of harmony in creation to consider the mind of the brute as in any way different in kind from the mind of man. The difference is in degree only, and in man we find all the powers of all animals combined, instincts included, some scarcely discernible, others prominent in his character; but they are all there, and it is this combination that gives him command of all the elements as the master of the world. We may seek in man for illustrations of all the mental and physical qualities of animals, and perhaps do better by reasoning upon facts associated with experience, than upon facts removed from the range of experience. Thus, instead of inquiring what is the nature of purely physical instincts in brutes, let us ask what is their nature in man. The beating of the heart, and the peristaltic motion of the intestines, are called physical instincts; they are performed involuntarily, and are ordinarily independent of the will. But what is the act of swallowing? It is a voluntary act, yet for the most part it is performed without a thought; and while engaged in an animated conversation at the dinner table, we swallow without knowing it, and sometimes without having knowingly experienced any sensation of pain or pleasure from the flavour of the food which has been passed to the stomach. A deliberate act of deglutition is certainly the result of mind in action—the will is operative, and we know what we do, and why we do it; but an unconscious act of swallowing is instinctive, and the first act of swallowing by a newly-born infant just put to the breast is an instinctive action. Without certain of these aboriginal instincts, animal life would be impossible; but their range is limited, and they are all physical in their nature, and it is manifestly erroneous to class them with actions that imply choice, and that are evidently the result of some kind of calculation based upon experience. Whenever the action is

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elective and conditional we assume the existence of mind, and see signs of its activity. From such instances as these we may trace the gradations upward to the highest attainments of reason, but we must never forget that we are tracing a gradation and not passing from one category to another, from one kind of reason to another kind of reason, any more than we would dare to assert that there are two kinds of matter, knowing, as we do, there is but one.

Through not keeping these principles in view, M. Flourens has gone quite astray from the truth in his amusing but superficial essay. He says, "the cry of an animal can reveal an idea, but is not the produce of an idea;" as if he had for some time lodged in the brain of a brute, and had satisfied himself of its destitution of ideas. "Animals," he says, "have no language, their cries are not known signs, they have their natural voice, but they have no speech," as if for the purpose of communicating information and ideas by vocal sounds, which from everyday experience we know they do, it were necessary for them to frame grammars and write epics. "Reflection well defined," he says, "is the knowledge of thought by thought. And this power of thought upon thought gives us all an order of new relations. As soon as the spirit sees, it judges; as soon as it can act by itself, it is free; as soon as it is free, it becomes moral. Man is only moral because he is free. The animal follows the body; in the midst of this body, which is enveloped in matter, the human mind is free, and so free that it can, when it wishes, even immolate the body itself." We have a parrot which occasionally sings—

> "I am perfectly free
> To climb up a tree,
> But I can't get out of my cage."

We fancy M. Flourens, with all the freedom he accords to man, is himself very much in the condition of our parrot.

ASTRONOMICAL NOTES.

DOUBLE STARS (*Concluded*).—PARALLAX OF MINUTE STARS.—QUADRATURE OF VENUS.—TRANSITS OF JUPITER'S SATELLITES.—OCCULTATIONS.

BY THE REV. T. W. WEBB, M.A., F.R.A.S.

DOUBLE STARS.

In this, which will form the concluding portion of our list of the more conspicuous binary and double stars, will be comprised a number of objects which, with few exceptions, are not conveniently visible at the present time, but which, having been omitted at their proper season for want of room, have formed a gradual accumulation. From the peculiarly unfavourable nature of the skies of last year, and from the interruptions occasioned by moonlight, there is little doubt that the objects enumerated in former papers can have been but partially recognized by the student. He will, therefore, have on hand a considerable *residuum* of his own, to which the greater part of the following list may be considered an addition, and the whole reserved for future opportunities.

We begin with a very beautiful and interesting pair of thoroughly-established binary character. A line drawn through *a* and *β Ursæ Majoris* (the *Pointers*) towards the S. will pass nearly through *ψ*, a 3-mag. star, and, if continued, will direct the eye to two 4-mag. stars near together: the furthest or southernmost of these is our object—

106. *ξ Ursæ Majoris*. 1″·8. 207°·5 (1830·94). 2″·9. 123°·5 (1851·31). 4 and 5½. Subdued white and greyish white. The great change thus indicated in little more than 20 years is brought down to 1857·357 by Secchi, the mean of whose measures is 3″·111 and 109°·74. This very fine binary system possesses a peculiar interest from the fact that it was the first whose orbit was ascertained from calculation. Sir J. Herschel had recommended especial attention to it in 1825, but Savary, a French mathematician, who died young, published, in 1830, the first elements of an ellipse computed by a method of his own from the previous observations, beginning with 1782, and inferred a period of 58¼ years. This, though not entirely confirmed by subsequent measures, was an approximation deserving of great praise, for Herschel has given 59 and 61 years, Smyth 65 and 60, and Mädler and Villarceau have very nearly agreed upon a period of 61½ years. There have been many unexplained discordances, but since considerably more than a whole rotation has been accomplished since its first discovery, there can be no question as to the broad fact that these two beautiful

suns are revolving round each other in a period actually shorter than that of the planet Uranus. In addition to this they possess a considerable amount of combined proper motion.

Reverting to *a Persei* (Int. Obs. XI. 374), about halfway from that star to ϵ (the nearest star) in *Cassiopea*, we come to—

107. η *Persei*. 28″·4. 300°·4. 5 and 8½. Reddish yellow and blue; a minute and elegant object. On reviewing this star during the present season, I found that it was surrounded by that peculiar crimson glare, or fringe of more intensely-coloured light, which has been already referred to in the case of λ *Herculis* under No. 39 (Int. Obs. VIII. 136). More careful examination, however, convinced me that the appearance was a deceptive one, arising from the eye-piece having been pushed in beyond the correct focus; and, since I found that such a border could be thus produced at pleasure, I have felt doubtful whether the supposed phenomenon has in any instance a real existence.

108. ϵ *Persei*. 8″·4. 9°·1. 3½ and 9. Pale white and lilac. Stationary. 1849·84, I thought the companion very small for its assigned magnitude. A month later, Mr. Hind, with the late Mr. Bishop's large achromatic, was of the same opinion; and I have renewed my impression this spring. Dembowski, however, in 1855, made it 8 mag. of W. Struve's scale, which would not differ much from Smyth's estimate. It is to be found on the edge of the galaxy, nearly equidistant from *a* Persei and the *Pleiades*, but considerably to the E. of the line which joins them.

Nearly in a line from this star to the *Pleiades*, and about halfway, we meet with—

109. ζ *Persei*. This interesting and elegant group is quadruple, at 13″·2, 82″·9, and 121″, with corresponding angles of 206°·6, 198°·1, and 185°; the magnitudes being 3½, 10, 12, and 11, and the colours flushed white, smalt blue, ash-coloured, and blue. The nearest star seems the faintest, unless care is taken to exclude or allow for the overpowering light of its large neighbour. Herschel II., Dawes, and Knott have seen a 5th star, still more minute, which is not mentioned by W. Struve or Smyth. Knott's measures, 1860·84, give 33″·6 and 290°·24. He also finds 89″·9 (mean of 4) for the distance of the second of Smyth's *comites*.

After a long interval we now return to finish the constellation *Cassiopea*, where several good objects are yet remaining for us.

110. ψ *Cassiopeæ*. 31″·9. 102°·1. 4½ and 9. Golden yellow and ash-coloured. The smaller star is again attended by a still more minute companion, 11 mag., discovered by W. Struve, with a distance of 3″·01, 1831·04, which Smyth mea-

sured 2″ and 252°·6, 1836·28. Secchi finds 2″·255 and 256°·45 as his means, 1858·822, both the little stars being white; and thinks it probable that the whole group may be physically connected and in perceptible motion. Should this indeed be so, how wonderful and glorious must such a spectacle be to an eye placed at a moderate distance, and how much more magnificent than any mere planetary combination! The object is an excellent test for a good telescope, especially as regards definition; but we must take a little pains in finding it. We have first to make out κ *Cassiopeæ*, 4 mag., which lies nearly n from α (see Int. Obs. VII. 57), and turns the triangle formed by β, α, and γ (the p side of the letter W) into a trapezium or irregularly-formed lozenge; then two lines run through β (the right-hand or leading star of the W in the diurnal motion) and κ, and through α and γ, will converge to a point somewhat beyond ψ. ψ also lies nearly n from δ, the fourth of the five principal stars.

If we run a line from our new acquaintance κ *Cassiopeæ* through β, and bend it a little to the s, or downwards (if we turn it a little upwards it will fall upon the wrong star, ρ, which is nearer β), we shall be guided at a little distance to—

111. σ *Cassiopeæ*. 3″. 323°·7. 6 and 8. Flushed white and smalt blue. Smyth calls this a miniature of ϵ *Boötis*, but with less fine colours. I made the companion tawny, 1850·71, but I have seen it blue this season with my present instrument. This illusion has been already referred to under Nos. 29, 62, 79, and 80 of the present list. Secchi finds little indication of motion. A low power exhibits this delicate and pretty object in a noble field, containing a second 6-mag. and several other considerable stars.

A line carried through δ and ϵ points nearly, at an equal distance, to—

112. 72 P. II. *Cassiopeæ* (ι of the catalogues of Dorpat and Rome). 2″·1. 274°·2. 4½ and 7. Pale yellow and lilac. A 9-mag. star of a fine blue tint stands at 7″·5 and 107°·1, making up a beautiful group. Dembowski gave the colours in 1854-1856, white, blue, and ruddy violet. The close pair forms an excellent test, requiring some amount of magnifying power. Secchi, combining Herschel I.'s measure, 290°·2, 1782, with his own, 265°·2, 1859·845, thinks an angular motion and a physical connection certain as to the close pair: the remote star seems unmoved.

In the galaxy, between α *Cygni* and *Cassiopeæ*, but rather nearer to the latter, the eye readily catches a triangle of 4-mag. stars, of which the base faces *Cygnus*. The apex is occupied by—

113. δ *Cephei*. 40″·9. 192°·2. 4½ and 7. Deep yellow and

cerulean blue. This is a magnificent wide object, almost equal to *β Cygni*, and one of the finest combinations of brightness and contrasted colour in the heavens. Common proper motion is suspected, and there are some indications of orbital revolution. The principal star is variable, and has the additional interest of being, according to Humboldt, the most perfectly regular in its returns of all these marvellous objects, since its discovery by Goodricke in 1784. The exact duration of its variation is given by Argelander at 5d. 8h. 47m. 39·5s. (Johnson however preferred 5d. 6h. 42m. 18·4s.), and its amount at about one magnitude or somewhat more, 3½ being the *maximum*. Its increase and decrease are singularly unequal, being respectively 1d. 15h. and 3d. 18h.; but during 8h. of the latter period it scarcely changes, and very inconsiderably so for a whole day. We have hitherto touched very little upon this most curious branch of inquiry, which, at some future time, may well claim our attention. With a low power, δ *Cephei* lies in a beautiful field, comprising, among other stars, a very pretty little triangle at a short distance *n f*.

If we draw a line from *Polaris* to *a Cygni*, at about two-thirds of the distance, but somewhat bending out towards *Cassiopea*, we shall find a 3-mag. star, the brightest of the vicinity. This is *α Cephei*, or *Alderamin*. Between this star and *Polaris* lies a similar star, *β Cephei*. *γ Cephei*, of the same magnitude, the third and last of the leaders of this obscure constellation, is nearly equidistant from *β* and *Polaris*, but bends down towards *Cassiopea*. We must here imagine a rhombus, or lozenge, of which *Polaris* and *β* occupy the two acuter ends, while *γ* stands at one of the obtuse angles; then, near the opposite obtuse angle, but pushed as it were a little in and downwards from its correct position, lies our next object, the brightest of its immediate neighbourhood: it is—

114. *κ Cephei*. 7″·5. 123°·8. 4½ and 8½. Pale yellow and blue. W. Struve calls the large star greenish. Secchi thinks a very slow motion probable. This is a very beautiful pair, and in a fine low-power field.

About halfway between *β* and δ *Cephei* (No. 113), we find—

115. *ζ Cephei*. 5″·8. 288°·8. 5 and 7. Smyth called them both bluish, 1839·65: flushed and pale lilac, 1851·4. W. Struve found them yellowish and blue, 1831·77. I thought them white and tawny or ruddy, 1850·63. This very fine pair is stationary.

116. 232 with 230 P. XII. *Camelopardi*. 21″·8. 327°·3. 6 and 6½. Bright white, with which the Dorpat catalogue agrees; but in 1852 I thought the colours of this superb pair a little dissimilar with my $3\frac{7}{10}$-inch glass, perhaps pale yellow and pale violet; and though the difference seems now but

trifling with $5\frac{1}{2}$ inches, they do not appear to be a perfect match. This object is said to be stationary; implying, of course, only that the measures have hitherto shown no appreciable motion; but its aspect is decidedly that of a connected system, and if so, as in many other cases, relative movement will be certainly detected in the course of time, for we have every reason to believe that gravitation is universal, and two adjacent bodies under its influence, unless kept asunder by rotation, must infallibly rush together to their mutual destruction. The pair will be found about 7° from *Polaris*, in a line drawn towards ϵ *Ursæ Majoris, Alioth*, the fifth star of that constellation, beginning with the *Pointers*: it is the first object at all evident to the naked eye in that direction from the Pole.

Between γ *Cephei* and ζ *Ursæ Majoris, Mizar*, the star which opened our present list, we find two conspicuous 3-mag. stars. These are β and γ in *Ursa Minor*, a constellation lying chiefly between them and the Pole. From γ, which is the further of the two from *Polaris*, we draw a line back to γ *Cephei*; then, rather nearer to γ *Ursæ Minoris*, and rather below this line, *i.e.*, further from the Pole, we make out a star which will repay all this trouble in finding it—

117. 40 *Draconis*. 19″·9. 235°·3. $5\frac{1}{2}$ and 6. Both white, 1839·81; and so W. Struve, 1832·95 (a mean of 3 years); but after $3\frac{7}{10}$ inches had shewed them to me white or yellowish, 1850·7, I noted them with the same glass, 1856·91, "both yellow; largest star deepest:" and I found them the same, 1863·13, with $5\frac{1}{2}$ inches; the hue of the smaller being perhaps not an exact *shade* of that of the larger star. A smaller lilac star at no great distance forms a beautiful group.

The little catalogue which is thus for the present concluded has no pretensions to completeness in any point of view. Its original intention comprised only such Binary and Double Stars, selected from the Bedford Catalogue, as would be both visible to the naked eye and capable of being identified by verbal description; omitting those which might be thought too close or too minute for ordinary instruments, or not sufficiently interesting for general study. Many, however, it need scarcely be said, of these excluded pairs, occupy debateable ground, especially at a time when superior optical means are daily becoming more accessible; as, on the other hand, not all of those which have been inserted may have appeared to some observers sufficiently worthy of notice. But, if our readers are not weary of the subject, it may be occasionally continued by the addition of objects requiring explanatory diagrams, or drawn from other sources of information, as well as by fresh remarks, from time to time, upon such of those already

enumerated as offer any distinct features of change. In the meantime enough, it is hoped, has been laid before the student to enable him to spend many an hour of tranquil enjoyment in the contemplation of these beautiful systems, and in the admiration of their Creator's power and glory.

PARALLAX OF MINUTE STARS.

In the preceding series of papers on Double Stars, attention has repeatedly been directed to a very remarkable point in the arrangement of the stars, the knowledge of which is essential to any accurate conception of the structure of the heavens. It was long and naturally supposed that the most conspicuous fixed stars were also the nearest, and that their brightness was, at least in a general sense, dependent upon their situation with respect to ourselves. It is now capable of demonstration that this is a fallacy. As far back as the year 1826, Sir John Herschel stated that there were "plausible grounds for a belief that, in situations remote from the Milky Way, minuteness, on the average, is not the effect of distance;" and this belief may now be said to have ripened into confidence. It may still be doubtful whether such an assertion may be applicable to the *average* of stars in any portion of the heavens; but it is no longer a question whether, in many instances, it may not be capable of direct proof. A fair presumption would arise from the admitted fact, that the proper motions by which many of the stars are steadily changing their positions are by no means always the largest in the brightest individuals; still, this presumption would not amount to actual demonstration. This could only be attained in one of two ways:—either by showing that great differences of magnitude exist between the components of binary systems (and it is this kind of proof to which reference has repeatedly been made in our Double Star list), or by the most direct mode of all—that of the detection of an annual parallax; in other words, an apparent change in the star's place resulting from an actual change in the position of the observer's eye, as our annual orbit carries us round the sun. It has been for some time known that the parallaxes of several of the brightest stars are, if not absolutely insensible, as Peters found with regard to *a* Cygni, and as Airey has suspected in the case of *a* Lyræ, yet much smaller than that of 61 Cygni, a star of only the 6th magnitude, which, according to Sir W. Herschel's estimate, would have been about twelve times more distant; but it has been reserved to the present day to carry onward this demonstration to a much greater extent by applying it to stars of a far inferior order. This interesting result has been obtained by means of the excellent heliometer at Bonn, in the hands of M. Krüger. A star of the

8·9 mag., No. 21,258 of Lalande's Catalogue, and another of the 9· mag., No. 17,415-6 in the Catalogue of Oeltzen, had been pointed out by Argelander as remarkable from their large amount of proper motion, in the latter case amounting to 1″·2 annually. Thirty-six comparisons of the former with two other suitably-placed stars yielded an amount of parallax = 0″·260, with a probable error of 0″·020. The latter star, from a mean of forty-five similar comparisons, showed a parallax = 0″·247, with a probable error of 0″·021. This, if confirmed by future measures, would bring these inconspicuous objects actually nearer to us than Polaris, Arcturus, or even the magnificent Sirius himself, and must suggest very remarkable speculations as to the probable structure of the Universe.

QUADRATURE OF VENUS.

During the present month, Venus will be an especially beautiful object, both in point of form and brilliancy. With a diameter gradually increasing from 19″·4 to 26″·8, the phasis will pass from a gibbous to a crescent shape, through the intermediate stage of *dichotomy*, or apparent bisection of the disc by a straight line, like the moon in her first quarter. This epoch falls by calculation on July 20th. It is, however, a curious fact, and one well deserving of attention, that the observed dichotomy, when the terminator, or boundary of day and night upon the planet's globe, is sensibly straight to the eye, has been repeatedly found not to occur when it should, at the time of the greatest elongation from the sun, but a little earlier or later, according to the position of the planet towards the east or west. This was discovered by Schröter in 1793, who found the terminator perceptibly concave at the greatest elongation, and thought it arose from the comparative faintness of the central part of the disc, as observed with high magnifiers, and on the bright background of a daylight sky, which might convey an illusory impression of concavity. Beer and Mädler not only re-observed it at both elongations in May and October, 1836, but confirmed it by the discovery that, both before and after the quadrature, the measured breadth of the phasis was less than that given by calculation. They attempt to account for this by a comparison with the moon, in which a similar aspect is produced, as they say, to the naked eye, especially by day, from the generally darkening effect of the shadows of the mountains towards the terminator. But this does not seem satisfactory. It may be questioned whether the lunar terminator is not as frequently thrown out by elevated ridges, as withdrawn by shadows; and, at any rate, such illusions with regard to the moon occur only by day, while the concavity of the terminator of Venus has been observed

on a background which would admit of no supposition of the kind, when every portion of her glittering disc has stood out in vivid relief against a darkened sky. It is somewhat singular that Beer and Mädler do not appear to have tested the value of their own supposition, as they might easily have done, by actual examination of the planet under these circumstances; when, it is but fair to suppose, they would have been led to doubt its sufficiency. Before I was acquainted with any of these observations, I had noticed the concavity of the terminator at the greatest elongation, 1833, March 6th, not only at sunset, but as late as 7h., and I also saw it in 1836, May 16th and 17th, one of their own epochs; unfortunately I have no record of the hour, but believe it was not during the day-time. According to their determination in 1836, the sensible dichotomy, or quadrature, takes place when the planet is six days further from the earth than at its computed quadrature—that is, six days before or after the greatest elongation as given in the Almanac, according to the direction in which the planet is moving. At the present epoch, if their data are correct, the apparent dichotomy will take place about July 14th. This will be an interesting point for amateurs, and quite within their reach, if the instrument shows Venus fairly with a sufficient magnifying power, as any good eye can judge very perfectly of the straightness of a line; a mean, also, may be found by taking careful sketches between what appear to be corresponding degrees of convexity and concavity on either side of the apparent dichotomy.

TRANSITS OF JUPITER'S SATELLITES.

These are now becoming rare.—July 14th, I. leaves the disc at 9h. 40m., the shadow remaining 1h. 16m. afterwards. 15th. III. enters at 9h. 30m., the shadow of II. being at that time upon the planet. 21st. I. enters at 9h. 23m. 30th. The shadow of I. goes off at 9h. 15m.

OCCULTATIONS.

Two occultations only happen at convenient hours.—July 28th. ξ^1 Sagittarii, 6 mag., will be hidden at Greenwich from 9h. till 10h. 7m. 30th. 8 Aquarii, 6 mag., from 8h. 29m. till 9h. 20m.

LITERARY NOTICES.

Among the various publications recently received, we may notice—

McLeod's Wall Maps. No. 3, Geological, by Edward Weller, F.R.G.S. *Longmans.*—This map belongs to an educational series, and by its size and clearness is well adapted for class teaching. The course of rivers, chains of hills, and boundaries of counties are purposely made very distinct, which is not the case in some geological maps, of greater merit so far as their one scientific object is concerned. We suppose the colouring of the Ordnance Maps has been departed from for the sake of allowing certain details of physical and political geography to appear more plain. The departure, however, involves the disadvantage that the student must learn the value of a new set of tints if he pursues the study any further. Those chosen by Mr. Weller must be admitted, however, to answer their purpose very well, if we except Nos. 12 and 9, which are too much alike to mark the broad distinction between the New Red Sandstone and the Coral Rag, etc., which they respectively signify in his scale. For geology, apart from other information, this map would not bear comparison with the smaller one by Professor Ramsay, but that would not answer the purpose of Mr. McLeod's series, as the division of the counties can scarcely be made out, and the printing of the names is generally indistinct, in both of which the present map deserves commendation.

A Systematic Handbook of Volumetric Analysis, by Francis Sutton, F.C.S., Professor of Practical Chemistry, Norwich. *Churchill.* This work is intended for the use of persons who are acquainted with the elementary principles and facts of chemistry, and wish to acquire the new and valuable art of Volumetric Analysis by the employment of *titrated* solutions. Solutions are thus named from the French, and signify their having a definite strength, or power, so that the action of precipitation or otherwise, exerted by a given quantity, is readily capable of arithmetical expression, and thus indicates the quantity of the substance acted upon. This method is much used in the best laboratories, and we believe Mr. Sutton has made the first successful attempt at giving a clear practical elucidation of the subject in the English language. His examples range over the principal articles which a private student or a manufacturing chemist would desire to analyse, and drawings are given of the apparatus required.

A Manual of Physiology for the Use of non-Medical Students, by John Shea, M.D. *Churchill.*—We regret we can only afford this book a qualified praise. In some respects it is well done and intelligible, but an uninstructed reader would be led to many erroneous conclusions. For example, after the researches of Balbiani, the function of the nucleus in infusoria can scarcely be called "quite uncertain," nor is it correct to say that "among the protozoa the mode of reproduction is limited to that of fission and gemmation." In speaking of the bryozoa, or polyzoa, as they are more commonly called, Dr. Shea merely observes that reproduction occurs in a manner similar to the process of budding in the hydra, and in the next

paragraph he speaks of the tunicata, and says that their multiplication either takes place by gemmation, "or by the more perfect method of development resulting from the meeting of sperm and germ cells." From this it would be inferred, contrary to fact, that neither the hydra nor the polyzoa exhibited in an elementary form the phenomena of sexual generation. The Edentata are spoken of as "quadrupeds wanting front cutting, or incisor teeth, their food being chiefly vegetable." As other animals show, there is no connection between the want of incisors and a vegetable diet. Moreover, some of the Edentata have no teeth at all, and many are insectivorous. It is in these natural history portions the most prominent defects lie of a well meant and, in some respects, useful book.

LIBER CANTABRIGIENSIS, PART II. AN ACCOUNT OF THE CHANGES MADE BY RECENT LEGISLATION IN THE COLLEGES AND UNIVERSITY OF CAMBRIDGE, WITH AN APPENDIX CONTAINING THE EXAMINATION PAPERS FOR THE OPEN MINOR SCHOLARSHIPS IN 1861-1862, by ROBERT POTTS, M.A., Trinity College. *Parker.*—The title of this book sufficiently explains its object and contents. As an epitome of the way in which the Legislature has dealt with certain endowments to make them conform to the spirit of the age, the statement has a general interest beyond the class for whose benefit it has been specially compiled.

EXPERIMENTAL ESSAYS, by CHARLES TOMLINSON, Lecturer on Physical Science, King's College School, London. *Virtue Brothers.*—This excellent little book we have noticed before, in the article on the "Motions of Camphor," which appeared in our May number.

THE INSECT HUNTER'S COMPANION, by the Rev. JOSEPH GREENE, M.A. *Van Voorst.*—Is a popular and readable guide to the collection of insects, pupa digging, etc.

A FEW WORDS MORE ABOUT GOLD, by EDMUND HEAD BROWNE, of the Stock Exchange. *Groombridge.*—Is an important pamphlet on the gold question. Mr. Browne enjoys the credit of being one of the first to point out how the progress of industry would absorb the gold acquired from new diggings, and thus to a great extent neutralize the effect on prices which many economists were disposed to exaggerate.

PAGE'S INTRODUCTORY TEXT-BOOK TO PHYSICAL GEOGRAPHY. *Blackwood.*—Is a very cheap and admirably devised work. The information is given in an agreeable, intelligible style. Hard words are avoided as far as possible, and when inevitable, their derivation and meaning are explained. It is one of the best books we know, whether for class teaching or private study.

THE FLORA OF THE WEST RIDING: the Phanerogamous portion by L. C. MIALL; the Cryptogens by B. CARRINGTON, M.D. Ed., F.L.S., etc. *Pamplin.*—We cannot speak of this little book from any personal knowledge of its subject, but we understand that those who are competent to form an opinion consider it to be what it appears, a work of industry and merit. The information concern-

ing the locality of the various plants will be serviceable to collectors and those who study the distribution of the Flora of the British Isles.

HANDBOOK OF THE BRITISH FLORA, by GEORGE BENTHAM, F.R.S., President of the Linnæan Society; with Engravings from original Drawings, by W. FITCH. Part I. *Lovell Reeve & Co.*—This new botanical work is intended, as the title-page informs us, "for the use of beginners and amateurs." Mr. Bentham's name leaves no doubt concerning its scientific value, and the information is conveyed in a much simpler and more intelligible style than botanists often think proper to employ. The descriptions will be readily understood if the student has "Henslow's Dictionary of Botanical Terms" to refer to: and the engravings, which are very numerous, are carefully executed.

PROFITABLE GARDENING, by SHIRLEY HIBBERD, F.R.H.S. *Groombridge and Sons.*—In the space of a small, elegantly-printed volume, Mr. Hibberd has condensed the results of his well-known skill and experience, so as to offer to the public "a practical guide to the culture of vegetables, fruits, and other useful outdoor garden products." Thousands of families will rejoice in good vegetables through these admirable directions how to grow them. Few men know as much of their subject as Mr. Hibberd, and still fewer can impart such knowledge in so pleasant a way. The book is full of valuable observations, and as it is a matter of national importance, we recommend every cultivator of potatoes to note what Mr. Hibberd has to say with reference to avoiding the disease.

A POPULAR TREATISE ON PHOTOGRAPHY, translated from the French of D. VON MONCKHOVEN by W. H. THORNTHWAITE. *Virtue Brothers and Co.*—The clearness of the descriptions, the multiplicity of the illustrations, and the cheapness of this work commend it strongly to the attention of beginners in a delightful art.

LONDON SCENES AND LONDON PEOPLE: Anecdotes, Reminiscences, and Sketches of Places, Personages, Events, Customs, and Curiosities of London City, Past and Present, by ALEPH. *Collingridge.*—A very elegant volume, the subject of which is sufficiently indicated by its title. We have read it with much pleasure, and shall hope that the subject will be continued, as many points of interest remain untouched, and the march of change—not always improvement—is rapidly destroying monuments of national as well as local interest. The illustrations are beautifully executed, and must give permanent value to the work. We ought to add that the papers are reprinted from the *City Press*, to whose popularity they contributed in no slight degree. They are good specimens of their class of writing, graphic and lively.

PROCEEDINGS OF LEARNED SOCIETIES.

BY J. W. TERGEMEIER.

CHEMICAL SOCIETY.—*May* 22.

On the Effect of Intense Heat on Liquids.—The paper by Mr. Grove, which was announced under the above title, excited much interest among the members of the society. Mr. Grove first called attention to the difference existing between the boiling of water under ordinary circumstances, and that of sulphuric acid. He stated that the equable evolution of steam, when water is boiled in an open vessel, is caused by the presence of a certain amount of air dissolved in the water, and that boiling may be regarded as an evaporation into the liberated bubble of air set free by the elevated temperature. In an open vessel a sufficient amount of air is continually reabsorbed, so that the ebullition goes on equally. On the contrary, when water is heated in a very long tube, it boils in the first instance evenly, but after the air is expelled it boils with the most violent concussions; during the regularly recurring intervals between the sudden and violent emissions of steam, the temperature rises far above 212°, and then a sudden explosive production of steam occurs, almost resembling the discharge of gunpowder.

By placing a portion of water in a flask under the vacuum of a good air pump, and heating it by the transmission of a strong electric current, passed through a fine platinum wire contained in the water, Mr. Grove proved that the water did not boil at all, but that the whole burst up into violent concussions at regularly recurring intervals.

Mr. Grove suggested that the phenomena of the Geysers, or intermittent explosive fountains of Iceland, would admit of a more satisfactory explanation by reference to these facts, than on the supposition of the existence of complicated subterranean chambers.

In the course of his experiments Mr. Grove ascertained that it was almost impossible to free water from gaseous bodies, and that the steam liberated from this liquid when boiled under oil, always leaves a small bubble of permanent gas; when condensed, this gas was found to consist of nitrogen.

These views of Mr. Grove's appear equally interesting in a practical, as in a strictly scientific point of view. It has been already suggested by Mr. Church that the violent and dangerous concussion arising during the distillation of sulphuric acid in glass retorts, may possibly be prevented by the passing a small stream of finely divided air through the boiling liquid. And it appears to the writer that many of the mysterious explosions that occur in steam-engine boilers, and which have hitherto never been satisfactorily explained, may be due to the expulsion of air by long-continued boiling, and the explosive liberation of steam as a consequence.

The report of this highly valuable paper of Mr. Grove's is not

as complete as might be wished. But in the pestilential atmosphere existing in the upper part of the meeting-room of the Chemical Society, it is almost impossible to follow the course of an argument. The Chemical Society has the pre-eminence of meeting in the worst ventilated room in London.

ROYAL INSTITUTION.—*June* 12.

Preparation of Magnesium.—At the evening meeting of the members of the Royal Institution Mr. Tegetmeier exhibited a mass of magnesium which had been prepared by Mr. E. Sonstadt, who has recently patented a process whereby this metal may be obtained in quantity.

Mr. Faraday called the attention of the members to the remarkable properties of this metal. Its whiteness, resembling that of silver, and high metallic brilliancy, were shown by means of the electric lamp. A wire of the metal was ignited in the flame of a candle, when it burnt with a white light of such dazzling intensity as totally to obscure the ordinary illuminating agents, such as gas and candles, and to rival the brilliancy of the electric light. Mr. Faraday stated that notwithstanding its strong attraction for oxygen, it was preserved from change, when in a mass, by the thin film of oxide covering and protecting the exterior surface from the exposure of the air.

Mr. Sonstadt's process for preparing magnesium on a manufacturing scale consists in decomposing a mixture of fused chlorides of magnesium and sodium by means of metallic sodium, and in the employment of iron vessels to effect the decomposition. It is found that the magnesium acts on the slica of earthenware crucibles, decomposing it, and uniting with the silicom; nor can platinum crucibles be employed, as the magnesium alloys with that metal, causing it to become fusible at a moderate temperature. The chloride of magnesium employed is best obtained from the mother liquor, left after evaporating sea water for its salt. Mr. Faraday stated that as every ton of sea-water contained above two pounds of magnesium in the form of chloride, the entire ocean would contain 160,000 cubic miles of magnesium. This would form a solid block fifty-four miles cube.

The specific gravity of magnesium is 1·75, resembling in its lightness the analogous metal alluminum. Now that magnesium is capable of being obtained quickly, there is no doubt that important applications of its singular properties will present themselves. The metallic bases of the earths are in so much greater abundance than the ordinary metals, that any attempt to isolate them for economic and practical purposes must be regarded with great interest, as bearing strongly on the advance of not only the scientific arts, but also of those having reference to daily life and advancing civilization.

UNIVERSITY COLLEGE.—*June* 10.

The Ordeal Bean of Calabar.—At the conversazione held at University College on the 10th of June, Professor Harley exhibited

specimens of the bean employed by the King of Calabar as a poisonous ordeal to determine the guilt or innocence of accused persons.

The plant yielding this bean is kept secret from the natives generally, and the seeds are consequently to be obtained only with great difficulty. The name that has been given to the plant is *Physostigma venenosum*, or *Calabar ordeal bean*. It belongs to the Leguminous tribe, having distinct papilionaceous flowers, succeeded by pods about six inches in length, each containing four or five seeds, having white cotyledons, resembling in taste the seeds of the common haricot, *Phaseolus vulgaris*. The leaves are ternate.

Taken internally the beans, unless rejected by vomiting, produce fatal paralysis. In some experiments made in this country it has been found that twelve grains have produced partial paralysis, threatening to be serious in its results. In the course of investigation into its properties, it has been ascertained that the extract of the bean possesses a most extraordinary power over the iris, a few minims of its solution dropped into the eye causing contraction of the pupil to such an extent that the aperture becomes entirely obliterated, and the eye possesses the appearance of having an imperforate iris. In order to demonstrate this action more fully, and to contrast it with the opposite effect of a solution of belladonna, a cat was exhibited, to one eye of which belladonna had been applied several days previously, causing dilatation of the pupil to such an extent that the iris was scarcely visible; to the other eye a solution of the ordeal bean had been applied, which caused obliteration of the pupil. The contrast between the two eyes of the animal was of the most marked character, and imparted a strange weird expression to the face. In the course of the evening the pupil dilated somewhat—the effect of the Physostigma passing away gradually in the course of about twenty-four hours, whereas that of the belladonna persists for many days. Specimens of the plant have been raised in this country from the imported seeds.

GEOLOGICAL SOCIETY.—*June* 3.

On the Section at Moulin-Quignon, and on the peculiar character of some of the Flint Implements found there. By J. Prestwich, Esq., F.R.S., F.G.S.—The recent discovery of a human jaw and of flint implements of a peculiar type and fresh appearance at Moulin-Quignon has led to questions having been lately raised as to the age of the gravel-beds, and the antiquity of these remains. Mr. Prestwich showed how conflicting had been the evidence in support of the views formerly entertained, and gave a *résumé* of the proceedings of the Conference lately held at Paris and Abbeville, and remarked that the intrinsic evidence appeared to prove the spurious nature of the objects, while the evidence derived from the study of the beds had led to the opposite conclusion. The author then showed that, from the physical configuration of the district, corroborated by the presence of extinct mammalia distinctly of contemporaneous age, the modern age assigned to these beds by some geologists could not be maintained, and that, from the occurrence

of freshwater shells in both the high and low-level gravels, their formation must have been due to river-action, and not to a wave of translation or other modification of marine action. Mr. Prestwich concluded by stating that, whatever may be the conclusions drawn from the jaw and the flint implements, the age of the deposits is to him perfectly well determined as being of the early quaternary or post-pliocene period, older than the Menchecourt gravels, and anterior to the excavation of the valley of the Somme; and as some flint implements, the genuineness of which is not doubted, have been found in these deposits, the question of the antiquity of man will not be affected, whatever the conclusions arrived at with regard to certain others.

ROYAL GEOGRAPHICAL SOCIETY.—*June* 10.

African Explorations.—The President announced the return of Captains Speke and Grant from their successful expedition to trace the source of the Nile, and read the following letter containing intelligence from Madame Tinné and her daughter, who had proceeded in their steamer on the Bahr-el-Ghazal, the western affluent of the White Nile:—

"21*st March*, 1863.

"Here we are, come to a stop again; that is, as far as we can go in the steamer on the Bahr-el-Ghazal. We are near to an island which Petherick calls Kyt, but the natives call it 'Misr of Reg.' Its longitude is 26° 45′ East of Greenwich." [This may probably be depended upon, as Mr. Von Heuglin and his companion, both scientific men, are of the party.] "The Bahr-el-Ghazal is more like a very narrow canal. There is little to say of it. It winds through high grass and bulrushes, large plains with huts and flocks at a distance, and nothing else. This is a very difficult place to come to, as the river, though deep, is choked with rushes and a soft-wooded sort of tree, which breaks as our ships pass, but is very formidable to look at. The leaf is the same eternal mimosa-shaped leaf, and it bears a large yellow flower like broom, and very sweet scented. We came through it with the steamer, having the paddles taken off. Our learned friends have found sixty curious new birds and an unknown fish, as well as several new flowers and plants. Mr. Von Heuglin and the Doctor have made some valuable observations. No one the least scientific seems ever to have been here before us."

BRISTOL NATURALISTS' SOCIETY.

The first annual meeting of this Society was held on May 8th. The report disclosed highly satisfactory progress during the past year. Mr. W. Sanders, F.G.S., observed that a society of this kind ought to work out completely the natural history of the neighbourhood, and therefore it was desirable to notice matters of seemingly trivial import, as the habitat of rare plants and insects, the order of the geological strata, occurrence of fossils, the time of arrival and departure of migratory birds, the occurrence of rare species, etc.

Every member might aid in this, and communicate his observations, however trifling, to some member of the committee, for registration.

The following gentlemen were elected as the committee for the ensuing year:—OFFICERS OF THE SOCIETY: *President*, Mr. W. Sanders. *Vice Presidents*, Dr. Alfred Day, LL.D., and Rev. Canon Guthrie. *Hon. Secretaries*, Mr. A. Leipner and Mr. W. L. Carpenter. *Hon. Treasurer*, Mr. W. W. Stoddart. Dr. Beddoe, Dr. Martin, Dr. W. Bird Herapath, Dr. H. Tripp, Mr. Hugh Owen, and Mr. W. J. Fedden.

At the January and April meetings of the Society a very elaborate paper was read by Dr. Day, entitled, "An Account of the Methods used by Mr. Bunt in Investigating and Predicting the Tides of the Port of Bristol." After speaking of the action of the sun and moon, and the greater effect produced by the latter in consequence of her proximity, he remarked that every one of the numerous lunar variations had more or less effect on her tide, and the effect was complicated by the inclination of her orbit to the ecliptic: hence the subject was beset with very great difficulties, and accuracy of prediction could only be obtained by a lengthened series of close observations, and the classification of these according to some theory. Mr. Whewell having pointed this out, Mr. Stutchbury (then curator of the Bristol Institution) selected Mr. Bunt as the gentleman best qualified for the task. The author here paid an eloquent tribute to the talent, conscientiousness, and exactness of Mr. Bunt, showing how admirably he was fitted for the post, and read extracts from a long correspondence that took place between Mr. Bunt and Mr. Whewell, which was, he said, honourable alike to both in the highest degree, and he then proceeded to explain a model of Bunt's tide gauge, which had been in constant operation for twenty years, recording upwards of 14,000 tides. It consisted essentially of a float on the surface of the water in a wooden trunk inserted in the river, which float was counterpoised by a weight, attached to the other end of a cord, passing over a large wheel, on the prolonged axis of which was an eccentric with a pencil. This pencil, moved thus in a vertical direction, was pressed by a lever against a vertical cylinder, covered with paper, and kept revolving on its axis by machinery driven by an accurate clock. The effect of the two motions combined was to trace a curve on the paper, from which the height of the tide at any given moment might be readily determined. After a great number of these had been obtained, the first thing was to obtain from them a mean curve, called the normal, or semi-menual curve, of high waters. This was then projected into a horizontal line, and the intervals between the curves of observation and the normal measured upon it, and the results compared with the known declination and parallax of the sun and moon. From these data, correction tables were made, both for parallax and declination of the sun and moon, and Mr. Bunt believed that these could not be improved, as further observation and taking of means gave no better result. There were several other smaller corrections to make, but at the present time the result of twenty years' observations had been so systematised

that the actual prediction of the time and height of any future tide was obtained by shifting one curve, on transparent paper, over another, according to the desired date, reading off figures as in a "patent abacus," and adding the hours, minutes, etc., thus obtained to the time of the moon's meridian passage for that day, as given in the *Nautical Almanac*. When the actual results were compared with the predictions, the average error in time was only about one minute, the errors being greatest at neap-tide; the errors in height were greater, owing to the wind increasing or diminishing the height of a tide. Many curious facts were mentioned, as that the height of the tide varied with the height of the barometer, rising fourteen inches with a rise of one inch in the mercury; that the average velocity of the spring-tides was thrice that of the neap; that the height was greater at the mouth of the Avon, where also the mean sea-level was higher than round the coast of England; that the tide may rise in the first hour and a quarter as much as it falls in three hours and a half; that the highest possible rise of tide in the Avon, except with the aid of wind, was thirty-three feet; that at different places there was a different relation between the forces of the sun and moon, etc. Dr. Day concluded his paper by pointing out that these predictions, so successful, were entirely tentative, being, in fact, the results of five tentative processes.

At the January meeting, also, Dr. W. Bird Herapath made a verbal communication on the presence of arsenic and thallium in the medicinal preparations of bismuth, the former of which impurities might be removed on a manufacturing scale by boiling the bismuth with caustic soda; the quantity of arsenic varied, he said, from 1 in 433 to 1 in 1000.

At the February meeting, the President announced the discovery of the scales of the Holoptychius, one of the ganoid fishes allied to the Cephalaspis, in the beds of Old Red Sandstone at Portishead, at a depth of 600 or 700 feet below the mountain limestone. Hitherto no fossils had been found in these beds, and this discovery showed that they belonged to the upper of the three divisions of Old Red Sandstone.

Mr. C. B. Dunn then read a paper on "The Cotton Plant: its Nature, Cultivation, and Use."

Mr. Hugh Owen read a paper entitled, "Great Departure from established Types not always sufficient Reason for specific or generic Distinction among the Mollusca," giving numerous examples (illustrated by specimens) of shells, with distinct generic or specific names, where they were really only earlier stages in the growth of the animal, or forms modified by accidental circumstances of climate, food, etc., as was proved in many instances by the exhibition of a graduated series, showing one form imperceptibly passing into the other, and he stated that some of the species makers were in the habit of destroying these intermediate terms of the series, so as to render the difference between the extremes well marked.

The March meeting of the Society was occupied with a very elaborate and interesting paper from Mr. W. W. Stoddart on Fossil Otoliths, and the auditory organs of the lower animals.

We abstain from reporting this paper, as we understand that Mr. Stoddart, after some further researches, intends to write a memoir on the subject himself.*

At the annual meeting in May, it was agreed that the months of June, July, and August should be devoted to excursion meetings, similar to those held last year.

W. Lant Carpenter, Secretary.

NOTES AND MEMORANDA.

Effects of the Calabar Bean on the Eye.—Mr. H. Carter Wigg communicates the following interesting facts:—"Before the discovery of the powers of this bean, by Dr. T. Fraser, a few months ago, no agent for the contraction of the pupil was at our command. Its action on the eye is singular and valuable; shortly after its introduction, as an extract or solution, there is some pain in the parts connected with the pupil, and gradual contraction of it till it becomes the size of a pin's point. It has even, as Mr. Soelberg Wells states, the power of causing contraction of the pupil when applied after the head is cut off. When 1-20th drop was placed in the eye of the writer, it induced marked contraction in less than two hours. It is produced from a leguminous plant of great size, the *Physostigma venenosum* (sub-ord. Papilionaceæ), with long thin stems. As a poison it is most powerful. In an experiment performed by Professor Harley, of University College, a fragment the size of a millet seed was used to poison two animals (a cat and a rabbit) successively, and on being removed from the body of the second, still retained sufficient strength to contract the pupils of another animal." For some additional particulars, see page 461.

Function of the Contractile Vesicle in Rhizopods.—Dr. Wallich, in the third paper in the *Annals of Natural History*, on the Amœba villosa, confirms the statement of Carter, that in rhizopods the contractile vesicle invariably discharges itself externally, and he says it does so through an orifice which is not of a permanent nature.

The Species Difficulty.—Dr. J. E. Gray states, in *Annals of Natural History*, that he finds "two very distinct forms of *Anthriscus silvestris*" growing side by side on the banks of the Thames, between Kew and Richmond—one is a large succulent plant, of a bright, rather palish green colour, much branched, and with large broad leaves; the stem is thick, and has a few large ridges, and the flowers are rather large; the other is a slender, rigid-stemmed plant, with comparatively few and distant branches, and comparatively few and smaller leaves; the stem has many small unequal ridges; the stem and foliage are always dark. He remarks that these differences cannot arise from soil, situation, etc., as they grow side by side, and flower at the same time.

Observations on Mars.—The *Proceedings of the Royal Society*, No. 55, contains a paper with drawings of Mars, by Professor Phillips. He regards the "broad white, or rather reddish band, which, from about 65° N. L., spreads up into large, cloud-like prominences towards and beyond the equator, and retires into one of the principal and several smaller bays towards the pole," as one of the main features very firmly defined in the last opposition. On comparing the sketches of Professor Phillips and Mr. Lockyer, it was found that the differences principally affect the gray southern parts, and are remarkable enough to justify serious doubts whether any of our drawings of those parts are much to be trusted as representing permanent physical boundaries. Mr. Phillips adds that this is not surprising, as the "enormous transfer of moisture from one hemisphere to the other, while the snows are melting round one pole and growing round the other, must generate over a great part of the planet heavy storms and great breadths of fluctuating clouds, which would not, as on the quickly rotating mass of Jupiter,

* The paper will be found in our present number.

gather into equatorial bands, but be more under the influence of prominent land and irregular tracks of ocean."

THE ECLIPSE OF THE MOON, JUNE 1ST.—The total eclipse of our satellite was beautifully seen in London, although in some districts, if not in all, a fog-coloured cloud took off the sharpness of the commencing shadow. Both in London and Paris a greater quantity of light was noticeable at the upper part of the moon, which was nearer than the lower part to the limit of the earth's shadow. The entire disk was seen at the height of the eclipse, and different portions exhibited varieties of tint as well as of luminosity. M. Flammarion commenting in *Cosmos* on this visibility of the disk, considers the best explanation to be that of Arago, which has not met with general acceptance; namely, that in consequence of the irregular refractive power exercised by the earth's atmosphere, certain portions of sun-light are bent out of their course and fall upon the moon within the calculated dimensions of the cone of shadow. He considers it cannot arise from a light proper to the moon herself, as the annals of astronomy tell of many instances in which her disk was completely hidden by the eclipse, especially in that on 25th April, 1642, described by Hevelius. As the moon was obscured on the 1st ult., stars, previously lost in her light, began to appear, and small ones seen through the telescope were beautifully bright. In Paris it was remarked that the copper-red tint usually observed was exceedingly faint. In London it was sufficiently noticeable to have a very solemn effect.

SECRETION OF UREA AND CHLORIDE OF SODIUM.—Dr. Emil Becher, assistant-surgeon army medical staff, took advantage of a voyage to China to make a series of observations on the relation between air temperature and the secretions above mentioned, as carried on in his own person. He found a constant increase of the secretions with the rising temperature from 50° to 70°, and an equally constant falling off, with the further rise of temperature from 70° to 90°.—From *Proceedings of the Royal Society.*

CHANGE OF FORM IN METALS BY IRREGULAR COOLING.—Lieutenant-Colonel H. Clerk has communicated to the Royal Society some curious experiments on this subject. It appears that a wheel had to be shoed with a hoop tire, which was required to have a bevel of about $\frac{3}{8}$ths of an inch, and one of the workmen suggested that this could be accomplished by heating the tire red-hot, and immersing one half its depth in cold water. This was done, with the predicted result, the part out of the water being reduced in diameter. A series of experiments followed, with similarity of action, the cylinders always exhibiting a contraction above the water line, followed, if they were sufficiently high out of the water, by an expansion corresponding to that below the fluid. The explanation given is, that the parts under the water cooled quickly, and those above it slowly. If no cohesion had united the two parts, both would have obtained the same diameter, one first, and the other afterwards; but as the cohesive power of cast-iron, or other metal, is great, the under part tends to pull in the upper, and the upper to pull out the under. In this contest the cooler metal, being the stronger, prevails, and so the upper part gets pulled in, a little above the water-line, while still hot. But it has still to contract in cooling, and this it will do to the full extent due to its temperature, except so far as it may be prevented by its connection with the rest.—*Proceedings of the Royal Society.* The name of the workman who made this fundamental discovery ought to have been mentioned with due honour. He is a more important person in the transaction than Lieutenant-Colonel Clerk, who has taken care to secure the credit of what he has done in it. Science knows nothing of social vanities; the best observer stands the highest, whatever his rank.

FUNCTIONS OF THE LIVER.—The *Proceedings of the Royal Society*, No. 55, contain an important paper on "The Amyloid Substance of the Liver, and its ultimate destination in the Animal Economy," by Robert McDonnel, M.D. The author concurs generally in the views of Dr. Pavy, but with respect to the destination of the amyloid substance he considers that it is on its way upward, and that the process of healthy assimilation tends to promote it from the rank of ternary or hydro-carbonous bodies to that of quaternary or nitrogenous substances, and that its conversion into sugar is to be looked upon as a deviation from this

progressive course. From his own observations, and the statements of Brown-Léquard, Lehmann, and others, he views the liver as "a great blood-making organ, in which there is constantly going on a reconstruction of certain ingredients of the blood: that in it the fibrine, etc., which has done its work, is disintegrated, the hydro-carbons of the bile abstracted, and the nitrogen combined with the amyloid substance, which, instead of being normally changed into sugar, emerges from the liver, a constituent principle of the proto-plasma, from the bosom of which—to use the words of Bernard with reference to fœtal tissues—organic evolution is to be accomplished."

THE NUMIDIAN CRANE IN THE ORKNEYS.—Mr. William Reid, of Kirkwall, informs us that a pair of the above birds (also called the "Demoiselle") have been seen, and a male specimen shot at Deerness. The gulls and lapwings continually attacked the two strangers, which uttered a hoarse scream when pursued. The specimen which was shot was in good condition, but no aquatic animals, which constitute its usual food, were found in its stomach—only oats.

AN EARTHY RAIN.—On the 1st May a rain fell at Perpignan bringing down with it a red substance, which proved, on examination, to be a red meal mixed with fine sand. Similar substances fell on the same day at various points on the shores of the Mediterranean. At Perpignan there was a violent storm, accompanied by thunder.

MAIZE PAPER.—A writer in *Cosmos* states the paper used for the books printed for the primary schools in Austria is composed of the cellulose of maize, and has a yellowish tint, less fatiguing to the eye than the dead white of ordinary rag paper.

PECULIARITIES OF SMELL.—The insensibility of certain eyes to particular colours, and of certain ears to particular sounds, appear to have their counterpart in the insensibility of certain noses to particular odours. Thus a gentleman, who is fond of sweet-scented flowers, informs us that he does not recognize the peculiar odour of the syringa, although roses, violets, mignonnette, etc., produce their normal effect on his olfactory nerves. This singular fact suggests an interesting train of inquiry which we believe has been hitherto neglected.

VESSELS OF PLANTS.—M. Lestiboudois publishes in *Comptes Rendus* researches on the vessels which hold the coloured juices of plants. In the stipules of the *Ficus elastica* he says they are easily seen on removal of the epidermis. Coagulating the fluids by plunging the leaves into boiling water demonstrates the presence of true vessels in more difficult cases.

RUBY-COPPER.—Some very beautiful groups of arbical crystals of ruby-copper—the suboxide of that metal, Cu_2O, and known to mineralogists as *Cuprite*, have been lately found upon the porous cells of a Daniell's battery which had been long in use. They occurred upon the electrolytically-deposited copper, singly and in masses. Though visible to the naked eye, the beauty of their appearance was greatly enhanced when they were viewed under the microscope with a low power and a brilliant light. It would seem that cuprite is frequently deposited with electrotype copper, and that when copper of this kind is melted, the cuprite partly dissolves in the metal, lowering its conducting power for electricity. Specimens of such copper, indeed, do not yield on analysis their full percentage of metal, and the presence of silicon, phosphorus, or of other elements which reduce conducting power, has been therefore suspected in them. The phenomenon above referred to may help to explain the anomaly.